DOCUMENT RESUME

ED 064 957	24	EM 010 207

TITLE	EIN Software Catalog; Entries, Volume I.
INSTITUTION	Interuniversity Communications Council (EDUCOM), Boston, Mass.
SPONS AGENCY	National Science Foundation, Washington, D.C.; Office of Education (DHEW), Washington, D.C.
BUREAU NO	BR-8-0697/Attachment No. 1
PUB DATE	[72]
GRANT	OEG-0-8-080697-4468(007)
NOTE	564p.; See also EM 010 206, EM 010 208, EM 010 209, EM 010 210, EM 010 211, EM 010 212
EDRS PRICE	MF-$0.65 HC-$19.74
DESCRIPTORS	Behavioral Sciences; Biological Sciences; *Catalogs; Computer Oriented Programs; *Computer Programs; Earth Science; Educational Administration; Engineering; *Information Networks; Information Science; *Interinstitutional Cooperation; Library Science; Mathematics; Operations Research; Physical Sciences; *Program Descriptions; Statistics; Technology; Tests
IDENTIFIERS	*Educational Information Network; EIN

ABSTRACT

The EIN (Educational Information Network) is a non-profit operation which coordinates the sharing of educational computing resources. It is administered by EDUCOM and funded by the U. S. Office of Education and the National Science Foundation. EIN maintains a group of contact personnel at member institutions to serve as a liaison between the institution and EIN. Through these persons items of software are offered for distribution. EIN also publishes a catalog of the software which is available through the network. The four-volume catalog contains an alphabetical listing of the participating EIN members that are represented in the catalog by program descriptions; descriptions of each computer facility listed and its general pricing algorithm; abstracts of available programs, subdivided into 13 areas of application; three indexes--by EIN number, by descriptive title, and by keyword; and complete descriptions of programs, including user instructions, samples of input and output, and cost estimates. Volume one contains a description of the EIN, facilities descriptions, abstracts, and indexes. This volume is one of three which contain the complete program descriptions. (JY)

8-0697
PA 56

ED 064957

EIN SOFTWARE CATALOG: ENTRIES,
VOLUME I.

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
OFFICE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

EM010207

DESCRIPTIVE TITLE	Mann-Whitney U Test
CALLING NAME	MANNWH NUCC085
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Alan Lupa, Department of Chemical Engineering, Northwestern University Dennis R. Goldenson, Department of Political Science, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201. Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

This program calculates the Mann-Whitney U statistic and reports its significance at one of five levels of confidence (that is, accept H_0, $P > .10$; reject H_0, $P < .10$, $P < .05$, $P < .02$, and $P < .01$). There is no limit to the number of problems that can be handled. Each subsample in a problem can have up to 2,000 cases. This is purely arbitrary; if one would want a larger sample-size capacity, he could merely alter the DIMENSION statements in the source deck to the limits of core storage. Printed output gives the problem number, alphanumeric problem label, the sample sizes, the input variable format, the median and decile range for each group, the U-test statistic (the smaller value), the value of Z where the larger group is greater than 8, and a statement of the level of confidence in the significance of U. (For a one-tailed test, the points of significance are found by dividing levels by two.) Since many behavioral-science data do not achieve interval scaling, the U test is a very useful alternative for one who does not wish to make the assumptions required by the parametric t test in determining if two independent samples are drawn from the same population. It is one of the most powerful of the nonparametric inferential statistics.

continued

References

1. Siegel, S., *Nonparametric Statistics for the Behavioral Sciences* (McGraw-Hill Book Co., Inc., New York, 1956).

2. Mann, H.B., and Whitney, D., "On a Test of Whether One of Two Random Variables is Stochastically Larger Than the Other," Ann. Math. Statistics *18*, 50-60 (1947).

USER INSTRUCTIONS

Description of Input Data

(1) Problem card	Up to 80 alphanumeric characters labeling the problem
(2) Sample size card	Cols. 1-4 sample size of smaller group (right-justified) 5-8 sample size of larger group (right-justified)
(3) F-Type variable format card	Cols. 1-80 standard F format enclosed in parentheses
(4) Data	Smaller group followed immediately by larger group

Repeat (1) through (4) as often as desired.

Description of Output

Printed output gives the problem number, an alphanumeric problem label, the sample sizes, the input variable format, the median and decile range for each group, the U-test statistic (the smaller value, corrected for ties), the value of Z where the larger group is greater than eight, and a statement of the level of confidence in the significance of U. (For a one-tailed test, the points of significance are found by dividing levels by two.)

Error Indications

None

Limitations

There is no limit to the number of problems that can be handled. Each subsample in a problem can have up to 2,000 cases. This is purely arbitrary; if one would want a larger sample-size capacity, he could merely alter the DIMENSION statements in the source deck to the limits of core storage.

continued

000 0001

Job Deck Structure

```
Job card
LIBRARY (MANNWH)
LGO.
7-8-9 EOR
      Problem card
      Sample size card
      F-type variable-format card
      Data
          Repeat as needed
6-7-8-9  EOI
```

SAMPLE INPUT

```
'SEQUENCE.NU532741
VLORR.              .CM36600.     MANNWH
LIBRARY(MANNWH)
LGO.
'  END OF RECORD
 THIS IS A SAMPLE HEADER CARD FOR THE  TESTING OF THE MANN WHITNEY PROGRAM
00040007
(F2.0)
12
07
23
12
78
32
56
45
65
20
12
SAMPLE PROBLEM--THE LARGER GROUP IS GREATER THAN 8. THUS THERE IS A Z SCORE.....
00100013
(F2.0)
12
02
45
13
45
12
25
24
02
01
23
96
75
69
56
12
78
85
32
25
45
12
75
```

continued

```
SAMPLE PROBLEM-- DATA ARE IMAGINARY IN THESE PROBLEMS.
00230027
(F2.0)
10
20
20
24
15
20
15
25
25
21
21
15
25
16
11
16
16
16
12
26
26
12
12
17
17
22
17
27
27
27
22
13
18
18
13
28
13
23
28
28
23
23
14
14
24
19
19
19
29
29
'END OF INFORMATION
```

SAMPLE OUTPUT

```
PROGRAM MANNWH--
A PROGRAM CALCULATING THE MANN-WHITNEY U-TEST.
                                                            WRITTEN BY--
                                                            ALAN LUPA, DEPARTMENT OF CHEMICAL ENGINEERING
                                                            DENNIS R. GOLDENSON, DEPARTMENT OF POLITICAL SCIENCE
                                                            NORTHWESTERN UNIVERSITY, 1966

THIS IS PROBLEM NO.   1

 THIS IS A SAMPLE HEADER CARD FOR THE  TESTING OF THE MANN WHITNEY PROGRAM

SAMPLE SIZE--
THE SMALLER GROUP =    4
THE LARGER GROUP  =    7

DATA IS READ IN UNDER THE FOLLOWING FORMAT--
(F2.0)

                SUMMARY OF DISTRIBUTIONS

                   MEDIAN       DECILE RANGE

THE SMALLER GROUP =     12.0             16.0
THE LARGER GROUP  =     45.0             66.0


                MANN-WHITNEY U-TEST STATISTIC =    3


                SIGNIFICANCE OF U-STATISTIC--

                 ACCEPT NULL HYPOTHESIS AT .10 LEVEL OF CONFIDENCE


PROGRAM MANNWH-- THIS IS PROBLEM NO.   2

SAMPLE PROBLEM--THE LARGER GROUP IS GREATER THAN 8. THUS THERE IS A Z SCORE.....

SAMPLE SIZE--
THE SMALLER GROUP =   10
THE LARGER GROUP  =   13

DATA IS READ IN UNDER THE FOLLOWING FORMAT--
(F2.0)

                SUMMARY OF DISTRIBUTIONS

                   MEDIAN       DECILE RANGE

THE SMALLER GROUP =     12.5             33.5
THE LARGER GROUP  =     56.0             73.0


                MANN-WHITNEY U-TEST STATISTIC =   21


                SIGNIFICANCE OF U-STATISTIC--


                 Z = -2.71

                 REJECT NULL HYPOTHESIS AT .05 LEVEL OF CONFIDENCE
```

continued

```
PROGRAM MANNWH-- THIS IS PROBLEM NO.   3
SAMPLE PROBLEM-- DATA ARE IMAGINARY IN THESE PROBLEMS.

SAMPLE SIZE--
THE SMALLER GROUP =   23
THE LARGER GROUP  =   27

DATA IS READ IN UNDER THE FOLLOWING FORMAT--
(F2.0)


                    SUMMARY OF DISTRIBUTIONS

                        MEDIAN       DECILE RANGE

THE SMALLER GROUP =      16.0             13.0
THE LARGER GROUP  =      22.0             15.0


                    MANN-WHITNEY U-TEST STATISTIC =  213


                    SIGNIFICANCE OF U-STATISTIC--

                     Z = -1.89

                     REJECT NULL HYPOTHESIS AT .10 LEVEL OF CONFIDENCE
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was .324 seconds for central-processor time and 12.792 seconds for peripheral-processor time with a memory useage of 36,600 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—MANNWH

pages	
1,2	Identification & Abstract
3,4	User Instructions
5–8	I/O
9	Cost—Contents

DESCRIPTIVE TITLE	Subtle, Unbiased, Zealous Yatagen of Questionnaires	
CALLING NAME	SUZYQ NUCC150	
INSTALLATION NAME	Vogelback Computing Center, Northwestern University	
AUTHOR(S) AND AFFILIATION(S)	Program written by	Brent M. Rutherford, Northwestern University
	Converted for the CDC 6400 by	Janos B. Koplyay
LANGUAGE	CDC FORTRAN IV	
COMPUTER	CDC 6400 (Scope 3.1 O.S.)	
PROGRAM AVAILABILITY	Deck and listing presently available	
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682	

FUNCTIONAL ABSTRACT

This cycling program makes possible a scoring and weighting of questionnaire items, as well as providing comprehensive item-analysis measures, test-analysis measures, and factor analysis with varimax rotation of the tetrachoric interitem correlation matrix. For the purpose of item analysis, internal as well as external criterion scores may be utilized.

The program permits the user to correct and/or weight a set of test responses (including data that have already been scored). For the cases where some data values may be skipped or missing, there is an option for the insertion of a specified average value in their place. SUZYQ provides a count of the total-response score per item and per subject, expressed in *raw* score units, z score units, and t score units. In addition, a total-test-score frequency distribution is constructed, using the same three types of units.

The *total* test score is then subjected to an item analysis with corrections for the nonindependence of the calculated correlations.

continued

Finally, a two-way variance analysis is performed, using the method of Hoyt, with basic analytic parameters computed from the elements of the summary table. Options include item analysis by criterion and a derivation of up to ten factors from the tetrachoric interitem correlation matrix (using a Kaiser varimax factor analysis).

USER INSTRUCTIONS

Limitations

(1) No more than 190 variables
(2) No more than 99,999 subjects
(3) If a score is missing (blank or minus zero on the data card), it will be correctly accounted for by the program (so-called Biased Missing-Data Method)

Preparation of Data

The program expects cards in the following sequence

Title Card

Columns	*Contents*
1-72	Title to be printed on output (any alphanumeric characters)

Problem Card

Columns	*Contents*
1-5	Number of variables, right-justified (maximum 190)
6-10	Number of subjects, right-justified
11-15	Maximum number of principal components to be computed, right-justified If blank, the number will be determined purely by the eigenvalues. The program will replace any specification of more than 50 principal components by 50. A zero punched in this field will make the program compute means, standard deviations, and intercorrelations and go no further.
16-20	Maximum number of factors to be rotated, right-justified If blank, the number of factors rotated will be determined purely by the eigenvalues, except for an upper limit of 50. If this specification exceeds the number of principal components calculated, then the program will limit the number of factors rotated to the number of principal components calculated. A zero punched in this field will make the program skip rotation.
21-25	Minimum eigenvalue for which principal components will be computed. Punch for F5.2 format. If blank, will be taken as .8

continued

Problem Card *continued*

Columns	*Contents*
26-30	Minimum eigenvalue for which a factor is rotated. Punch for F5.2 format. If blank, will be taken as 1.0
31	Blank; input data located on cards 4; input data located on alternate tape (logical tape 4). Only the data cards described below can be on tape 4. The program and control cards (including this one) must still be on cards
32	Number of extra variable format cards (in addition to this one)
33	Blank; unities to be placed in diagonal of correlation matrix 1; squared multiple correlations to be placed in diagonal
34	Blank; correlation matrix will be printed 1; correlation matrix will not be printed
35-36	Blank
37-72	Variable format for one subject (must begin and end with parentheses and describe data in F format)

Variable-Format Cards (optional)

Columns	*Contents*
1-72	Continuation of variable format if needed. Up to 9 cards may be used, as specified in the problem card, Col. 32.

Variable-Name Cards

Columns	*Contents*
1-6	Name of first variable (any alphanumeric characters)
7-12	Name of second variable, etc., until
67-72	Name of 12th variable. Continue on as many additional cards as necessary. The total number of names must equal the number of variable

Data Cards

First comes the subject's score on the first variable, then his score on the second variable, and so on. The columns must conform to the variable-format statement.

continued

Additional problems may follow, each beginning with a title card and ending with data cards.

Job Deck Structure

```
Job, . . .
LIBRARY (FACTOR)
LGO
7-8-9 EOR (multipunch in Col. 1)
     Title Card
     Problem Card
     Variable Format Cards (optional)

     Data

6-7-8-9 EOI (multipunch in Col. 1)
```

Note: Specify CM110000 on job card for program FACTOR

SAMPLE INPUT

```
VLORR,              .CM110000.   FACTOR
LIBRARY(FACTOR).
LGO.
SCORES FROM DEPRESSION RATING SCALE
   13  150                           (12X, 13F2.0)
A      B      S-VA  AN    PEP   HY-S  HY-O  PD-S  PD-O  PA-S  PA-O  L                  1
INC                                                                                   2
         1     7 91329101321 8 7 6 6 5 1                                         PICHOT
         2     9121333 510261219 811 4 8                                         PICHOT
         3     6   825 811 6 916 6 9 2 0                                         PICHOT
         4     3121318 7 9161213 6 6 5 0                                         PICHOT
         5     4 81120 91020 9 9 4 8 9 5                                         PICHOT
         6     3141822 811291322 915 7 0                                         PICHOT
         7    1010123211 9 81211 2 2 5 2                                         PICHOT
         8     9 71518 811111111 5 7 6 1                                         PICHOT
         9    11151934 6 625 815 715 5 0                                         PICHOT
        10     715192411142510171121 8 2                                         PICHOT
        11    12 8 634 8 8 6 5 9 4 7 7 7                                         PICHOT
        12     3 51418 91215 717 8 7 4 1                                         PICHOT
        13    15 510321017 4 8 4 6 010 3                                         PICHOT
        14    16101232121021 514 516 7 6                                         PICHOT
        15     3131320 8 7221022 817 2 3                                         PICHOT
        16    10 411291016 8 910 4 3 4 0                                         PICHOT
        17     4 7 918 7111010 7 5 4 2 1                                         PICHOT
        18     8 3 9241016 91113 7 7 7 3                                         PICHOT
        19    16 91531 91017101010 5 3 1                                         PICHOT
        20    13 8 7361112 612 7 9 7 6 2                                         PICHOT
        21     9 612291116 710 4 8 1 5 9                                         PICHOT
        22    13 6 635 513 5 7 9 8 1 6 1                                         PICHOT
        23    13 3 723 623 6 9 7 6 3 6 1                                         PICHOT
        24     7 9 934 812 51117 711 1 6                                         PICHOT
        25    13121639 610231116 8 3 4 3                                         PICHOT
        26    13101737 6121510 7 8 7 6 4                                         PICHOT
        27     914193211 723 714 512 4 3                                         PICHOT
        28     8131331 71113 5 8 7 7 5 4                                         PICHOT
        29    14 91035 611 8 710 4 6 7 4                                         PICHOT
        30     5 61226 5231410 7 9 4 9 1                                         PICHOT
        31    10 1 727 916 613 6 7 511 3                                         PICHOT
        32    14 81631 710221411 710 9 4                                         PICHOT
        33     5 81020 712211521 917 0 2                                         PICHOT
        34    10 5 93212 9 11012 7 8 6 0                                         PICHOT
        35    1517203612 824 717 717 6 1                                         PICHOT
        36     9 51228 81121 8 9 4 6 8 0                                         PICHOT
        37    1213152911 627 922 714 2 7                                         PICHOT
        38     9121826 51416141411 7 4 0                                         PICHOT
        39     9 9 924 512211115 4 8 9 0                                         PICHOT
        40    13 51032 914 7 710 6 7 9 3                                         PICHOT
        41     7161127 61215 9171010 4 5                                         PICHOT
        42    14 51033 4141112 8 4 4 5 2                                         PICHOT
        43    1512 934 9 81411 9 8 5 2 3                                         PICHOT
        44    13121835 9172012 9 9 7 9 5                                         PICHOT
        45     4121421 614241218 712 4 1                                         PICHOT
        46    11 3 928 71012 817 411 7 5                                         PICHOT
        47    16 51534 8162310 9 9 6 5 2                                         PICHOT
        48    1311 9321014101316 7 9 5 3                                         PICHOT
        49     6101726 61119 8121011 3 1                                         PICHOT
        50     413152511 824 817 712 6 2                                         PICHOT
        51    1417114012 7251220 618 5 5                                         PICHOT
        52     6 7 917 416 31010 7 4 3 2                                         PICHOT
        53    11131327 71321 815 9 9 4 2                                         PICHOT
        54    11 51531 31815 8 711 5 7 3                                         PICHOT
        55    11 1 224 918 111 2 4 1 9 3                                         PICHOT
        56    15 61234 7 7 71115 6 7 5 3                                         PICHOT
        57    15131837 611 91211 8 8 8 4                                         PICHOT
        58     9 712231014211113 6 5 5 4                                         PICHOT
        59     8 9 926 5111413 4 5 3 7 0                                         PICHOT
        60     9 4 918 516 910 9 5 410 1                                         PICHOT
        61     9 61138 61014 9 7 5 4 4 0                                         PICHOT
        62    16 6113610 9141013 710 8 4                                         PICHOT
        63    1013 9341412121110 7 4 7 3                                         PICHOT
        64     8 71633 61715 5 9 6 7 8 7                                         PICHOT
        65     6 4 421 619131013 7 9 4 5                                         PICHOT
        66    12 711351212 511 6 710 5 3                                         PICHOT
        67    1615123613 8191017 715 1 1                                         PICHOT
        68    1516123714 624 717 714 2 2                                         PICHOT
        69    13101241 9 8 5 815 611 7 2                                         PICHOT
        70    14121040 9 7 4 714 912 7 3                                         PICHOT
        71    1311 931 8 7 9 9 3 4 4 5 0                                         PICHOT
        72     8 71119 8162011 9 8 6 7 4                                         PICHOT
```

continued

16/~~17~~

```
 73   14101531 913 5 7 8 3 2 4 2                                 PICHOT
 74   1311133110 7111110 511 3 6                                 PICHOT
 75   12 3 520 620 611 7 7 310 3                                 PICHOT
 76    7 4 320 216 211 7 2 3 6 0                                 PICHOT
 77   1513123911 512 615 616 7 2                                 PICHOT
 78   15 4 633 918 212 8 4 9 9 2                                 PICHOT
 79    6 4 923 316 51111 9 5 5 1                                 PICHOT
 80   16 6 735 71613 8 5 6 3 4 4                                 PICHOT
 81   16 81039 616 714 6 6 1 7 2                                 PICHOT
 82   13141927 61019 516 6 7 3 3                                 PICHOT
 83    710 621101515 818 814 7 9                                 PICHOT
 84    310 824 3151311 9 7 5 5 0                                 PICHOT
 85   11 5 729101216 911 511 2 7                                 PICHOT
 86   13 7 934 814 812 5 8 410 0                                 PICHOT
 87   10171831 9 625 920 914 5 1                                 PICHOT
 88   1110133410 813 4 9 2 6 4 3                                 PICHOT
 89   16 9 4411112 510 9 4 6 4 2                                 PICHOT
 90   12131236 8 4151017 5 6 6 4                                 PICHOT
 91   101010311315241518 815 8 6                                 PICHOT
 92   15 2 7341012 9 5 6 3 5 5 6                                 PICHOT
 93    6131323 5 7241224 919 1 1                                 PICHOT
 94   15 6 934 71619131410 5 5 1                                 PICHOT
 95   1410 93711 9 7 4 3 7 6 6 2                                 PICHOT
 96   13 71036 515131415 7 4 8 4                                 PICHOT
 97   1010133010 6181017 612 3 2                                 PICHOT
 98   10 9 729 81213 51210 8 5 8                                 PICHOT
 99   13 61328 8 911 6 6 6 3 6 1                                 PICHOT
100    4 8 815 616131217 810 6 1                                 PICHOT
101   10 0 612 320 814 7 9 3 7 3                                 PICHOT
102   1010 833 715111111 9 911 3                                 PICHOT
103    6 5 714 6201010 6 4 1 5 6                                 PICHOT
104   101210371017 415 6 9 8 4 0                                PICHOT
105   16141738 91314 812 5 8 6 3                                 PICHOT
106   16141241 9 82111101013 7 7                                PICHOT
107   14 9 334 416 413 6 8 212 0                                 PICHOT
108    9141429 91119 916 910 2 1                                 PICHOT
109   1411153511 419 918 613 2 3                                 PICHOT
110    8 8 925 9221711 5 6 8 8 4                                 PICHOT
111    4 91225 61111 910 7 812 4                                 PICHOT
112    610 930 61523 8 61113 8 5                                 PICHOT
113   12131238 9 5 9 814 716 5 3                                 PICHOT
114   1412133410 816 711 6 6 4 7                                 PICHOT
115    7 81221 4162011121110 9 3                                 PICHOT
116   10 9 732 5181612151212 9 1                                 PICHOT
117    8121633 5 920 811 9 8 7 1                                 PICHOT
118   15111632 6 522 614 8 9 5 0                                 PICHOT
119   12131431 7 917 911 8 8 5 9                                 PICHOT
120    7 4 226 620 311 8 6 412 1                                 PICHOT
121    6 4 416 320121211 9 9 5 2                                 PICHOT
122   10 7 629 7241715 610 5 5 0                                 PICHOT
123   13101835 510161114 6 6 4 0                                 PICHOT
124    9 6 4241016 613 5 6 6 8 2                                 PICHOT
125   14141735 8 922 918 612 4 0                                 PICHOT
126   11 6 829 61415 9 610 9 3 4                                 PICHOT
127   15 1 834 516 2 9 4 5 2 7 4                                 PICHOT
128   13 61130 810 9 6 610 711 1                                 PICHOT
129   11101526 41510101412 6 7 1                                PICHOT
130   1111 929 7 91610 8 6 6 1 5                                 PICHOT
131    7 4 415 5161313 612 8 4 2                                 PICHOT
132    3 6 816 222231218 814 612                                 PICHOT
133   14111135111119 6 6 6 4 8 4                                PICHOT
134    510 833 910141119 810 612                                 PICHOT
135   13161039121315 818 811 4 4                                PICHOT
136    5 8 917 718161516 5 6 3 4                                PICHOT
137    6131125 8 5211322 818 0 4                                 PICHOT
138    7101119 2121210 6 9 3 3 2                                 PICHOT
139   14 6 837 915151215 812 8 2                                 PICHOT
140   11 3 227 916 412 9 5 4 6 1                                 PICHOT
141   11 2 531 819 4 9 1 6 3 6 5                                 PICHOT
142    5 81428 714231016 510 7 3                                 PICHOT
143   12 81530 7 816 911 6 8 610                                 PICHOT
144   1210 932 913111111 4 6 6 4                                 PICHOT
145   15 2 228 621 313 7 7 110 2                                 PICHOT
146   10 3 932 719 611 6 9 1 8 7                                 PICHOT
147   1411 940 9 714 712 310 5 5                                 PICHOT
148   13 51230 911111117 4 7 8 6                                 PICHOT
149   1612144010 7281018 823 2 0                                 PICHOT
150    8 6 822 6142114131010 6 3                                 PICHOT
```

SAMPLE OUTPUT

```
PRINCIPAL COMPONENT FACTOR ANALYSIS PROGRAM

SCORES FROM DEPRESSION RATING SCALE

FORMAT OF DATA CARDS              (12A, 13F2.0)

                 13 VARIABLES

                150 SUBJECTS

                                   MEANS AND STANDARD DEVIATIONS

                        VARIABLE          OBS          MEAN          STD DEV

                         A                150        10.4867          3.7160
                         B                149         8.7785          3.8535
                         S-VA             150        10.8467          4.0430
                         AN               150        29.4467          6.6267
                         REP              150         7.7933          2.5444
                         HY-S             150        12.4867          4.3915
                         HY-O             150        13.8933          6.8953
                         PD-S             150         9.9333          2.4812
                         PD-O             150        11.5867          4.9659
                         PA-S             150         6.9733          2.1518
                         PA-O             150         8.0200          4.5325
                         L                150         5.7600          2.5189
                         INC              150         3.0000          2.4983


                                                CORRELATIONS

VARIABLE    A       B      S-VA    AN     REP    HY-S   HY-O   PD-S   PD-O   PA-S   PA-O   L      INC

 A        1.000

 B         .051   1.000

 S-VA      .066    .612  1.000

 AN        .742    .339   .209  1.000

 REP       .329    .303   .132   .434  1.000

 HY-S     -.226   -.618  -.500  -.415  -.384  1.000

 HY-O     -.166    .578   .597  -.031   .094  -.339  1.000

 PD-S     -.200   -.171  -.243  -.275  -.217   .379  -.018  1.000

 PD-O     -.187    .554   .408  -.010   .160  -.453   .581   .078  1.000

 PA-S     -.163    .176   .139  -.094  -.231   .171   .278   .221   .157  1.000

 PA-O     -.101    .560   .362   .109   .306  -.461   .621  -.042   .746   .266  1.000

 L         .083   -.357  -.222   .026  -.118   .389  -.284   .055  -.382   .004  -.285  1.000

 INC       .006   -.000  -.071   .063   .125  0.000   .080  -.136   .090  -.041   .103   .009  1.000
```

continued

```
                                                   PRINCIPAL COMPONENTS
                1       2       3       4       5
                                                        EIGENVALUES

              4.158   2.456   1.184   1.095    .959

                                                   PERCENT OF VARIANCE

             31.982  18.896   9.110   8.425   7.375

                                                      FACTOR LOADINGS

A              .101   -.794    .370   -.108    .124
B              .852    .012    .136    .065   -.030
S-VA           .711    .031    .224    .268   -.366
AN             .355   -.762    .350   -.157    .076
REP            .428   -.510   -.177   -.245    .331
HY-S          -.767    .314    .157   -.236    .026
HY-O           .727    .394    .047   -.070   -.183
PD-S          -.258    .490    .289   -.187    .615
PD-O           .745    .373   -.127   -.127    .216
PA-S           .136    .503    .609   -.264   -.148
PA-O           .781    .264   -.015   -.273    .152
L             -.482   -.149    .356   -.316   -.297
INC            .081   -.079   -.442   -.753   -.317



                                                    VARIMAX ROTATION
                1       2       3       4

                                                   PERCENT OF VARIANCE

             30.663  16.952  12.130   8.668

                                                ROTATED FACTOR LOADINGS

A             -.135   -.872   -.089    .043
B              .819   -.252   -.085    .083
S-VA           .698   -.202   -.077    .309
AN             .115   -.910   -.115   -.021
REP            .237   -.486   -.350   -.346
HY-S          -.626    .319    .519   -.076
HY-O           .816    .085    .148   -.034
PD-S          -.081    .284    .581    .015
PD-O           .817    .155    .005   -.191
PA-S           .312    .027    .779    .085
PA-O           .820   -.027    .090   -.270
L             -.490   -.241    .419   -.086
INC            .025   -.029   -.040   -.878
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 1.883 seconds for central-processor time and 18.814 seconds for peripheral-processor time with a memory usage of 110,000 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—FACTOR

pages	
1	Identification & Abstract
3–5	User Instructions
7–10	I/O
11	Cost—Contents

DESCRIPTIVE TITLE	Student's T and F Ratio (with provision for missing data)
CALLING NAME	STDNTF2 NUCC019
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

STDNTF2 is a larger, more complex version of STDNTF1 (see EIN No. 000 0013) and is capable of handling up to 500 T tests between two groups. Such a test compares an appropriate sampling (T) distribution with the normal distribution. The program tests also for consistency of performance on all tested variables.

The handling of multiple jobs, the availability of certain data transformations, and provision for cases in which the data contain missing items are features of this program.

USER INSTRUCTIONS

Description of Input

The input data consist of score cards for each group. Variable format may be used.

Cards	*Columns*	*Contents*
1	1– 2	Number of jobs to be done
2	1– 3	Number of subjects in the first group
	4– 6	Number of subjects in the second group
	7– 9	Total number of variables to be tested
	10–11	Transformation code (see below)
3		Variable format of the scores (F format only); format of the groups *must* be the same
4		Continuation of format. If not needed, blank card *must* be used.
5 ⋮ .		Score cards of the first group, followed by score cards of the second group; then header card (card 2 above) for the next job, and so on for subsequent jobs. (If no further jobs are to be done, simply end with last score card.)

Note: Subsequent jobs begin with card 2 above.

Description of Output

Only printout is obtained.
1. Means and standard deviations of the first group
2. Means and standard deviations of the second group
3. Number of degrees of freedom
4. Variable number and value of student's T for the difference between the two group means (for each variable)
5. A table of degrees of freedom and F ratios, to determine the appropriateness of the assumption of homogeneity of variances; T's are computed whether or not this assumption is rejected.
6. The results of the second group

⋮

etc.

continued

Transformation Codes

01– no transformation
02– log 10
03– square root
04– square
99– different for each variable (use transgeneration card of BMD Manual). Transgeneration cards should be inserted between cards 4,5 if used.

Job Deck Structure

```
Job Card
LIBRARY (STDNTF2)
LGO.
7–8–9 (EOR card)
      (Program Control Cards and data deck)
       Card 1– Number of jobs                              ┐
       Card 2– Subjects, variables, and transformation code│ Repeat
       Card 3– Format Card                                 │ for ad-
       Card 4– Format Card (must be present)               │ ditional
               Score cards for group 1                     │ jobs, if
               Score cards for group 2                     ┘ any
 6–7–8–9 (EOI card)
```

REFERENCES

The user is referred to the program BMD29 (Vogelback Computing Center, Northwestern University), EIN No. 000 0012.

SAMPLE INPUT

```
VLORR.CH[redacted]CM45000.   STDNTF2
LIBRARY(STDNTF2)
LGO.
04
  5  4  2 1
(2F2.1)

1020
2010
3010
2020
1020
2010
3020
1030
2010
  5  4  2 1
(2F2.1)

1010
  10
2010
10
  20
1020
2020
  10
30
  5  4  2 1
(2F2.1)

1020
 0
20 .
1030
1020
2030
2020
1010
2030
  3  3  401
(20F4.0)

  2.  1.  5.  7.
  2.  1.  1.  5.
  3.  2.  5.  6.
  8.  8.  8.  8.
  5.  5.  5.  5.
  4.  4.  4.  4.
```

000 0003

SAMPLE OUTPUT

```
STUDENTS   T-TEST.   WILL HANDLE MISSING DATA.

GROUP 1 MEANS
     1.800        1.600

GROUP 2 MEANS
     2.000        1.750

GROUP 1 STD. DEV.
      .837         .548

GROUP 2 STD. DEV.
      .816         .957

NUMBER OF DEGREES OF FREEDOM =
          7            7

VALUES OF STUDENTS T

VARIABLE  1 =      -.3600

VARIABLE  2 =      -.2977

VARIABLE   NDF 1   NDF 2   F RATIO
    1         4       3       1.05
    2         3       4       3.06
```

```
STUDENTS   T-TEST.   WILL HANDLE MISSING DATA.

GROUP 1 MEANS
     1.333        1.250

GROUP 2 MEANS
     2.000        1.667

GROUP 1 STD. DEV.
      .577         .500

GROUP 2 STD. DEV.
     1.000         .577

NUMBER OF DEGREES OF FREEDOM =
          4            5

VALUES OF STUDENTS T

VARIABLE  1 =     -1.0000

VARIABLE  2 =     -1.0249

VARIABLE   NDF 1   NDF 2   F RATIO
    1         2       2       3.00
    2         2       3       1.33
```

continued

000 0003

```
STUDENTS  T-TEST.   WILL HANDLE MISSING DATA.

GROUP 1 MEANS
     1.000       1.750

GROUP 2 MEANS
     1.750       2.250

GROUP 1 STD. DEV.
      .707       1.258

GROUP 2 STD. DEV.
      .500        .957

NUMBER OF DEGREES OF FREEDOM =
        7           6

VALUES OF STUDENTS T

VARIABLE  1 =    -1.7832

VARIABLE  2 =     -.6325

VARIABLE   NDF 1   NDF 2   F RATIO
    1         4       3       2.00
    2         3       3       1.73



GROUP 1 MEANS
     2.333       1.333       3.667       6.000

GROUP 2 MEANS
     5.667       5.667       5.667       5.667

GROUP 1 STD. DEV.
      .577        .577       2.309       1.000

GROUP 2 STD. DEV.
     2.082       2.082       2.082       2.082

NUMBER OF DEGREES OF FREEDOM =
         4           4           4           4

VALUES OF STUDENTS T

VARIABLE  1 =    -2.6726

VARIABLE  2 =    -3.4744

VARIABLE  3 =    -1.1142

VARIABLE  4 =      .2500

VARIABLE   NDF 1   NDF 2   F RATIO
    1         2       2      13.00
    2         2       2      13.00
    3         2       2       1.23
    4         2       2       4.33
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 0.304 seconds for central-processor time and 13.860 seconds for peripheral-processor time with a memory useage of 45,000 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—STDNTF2

pages

1 Identification & Abstract
3,4 User Instructions
5–7 I/O
9 Cost—Contents

DESCRIPTIVE TITLE	Subtle, Unbiased, Zealous Yatagen of Questionnaires
CALLING NAME	SUZYQ NUCC150
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Program written by Brent M. Rutherford, Northwestern University Converted for the CDC 6400 by Janos B. Koplyay
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400 (Scope 3.1 O.S.)
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

This cycling program makes possible a scoring and weighting of questionnaire items, as well as providing comprehensive item-analysis measures, test-analysis measures, and factor analysis with varimax rotation of the tetrachoric interitem correlation matrix. For the purpose of item analysis, internal as well as external criterion scores may be utilized.

The program permits the user to correct and/or weight a set of test responses (including data that have already been scored). For the cases where some data values may be skipped or missing, there is an option for the insertion of a specified average value in their place. SUZYQ provides a count of the total-response score per item and per subject, expressed in *raw* score units, *z* score units, and *t* score units. In addition, a total-test-score frequency distribution is constructed, using the same three types of units.

The *total* test score is then subjected to an item analysis with corrections for the nonindependence of the calculated correlations.

continued

000 0004

Finally, a two-way variance analysis is performed, using the method of Hoyt, with basic analytic parameters computed from the elements of the summary table. Options include item analysis by criterion and a derivation of up to ten factors from the tetrachoric interitem correlation matrix (using a Kaiser varimax factor analysis).

USER INSTRUCTIONS

Description of Input Data

The user must specify the following information.

1. Control parameters such as the problem name, the number of subjects and test items, and the desired option
2. Input format
3. Test-scoring key (correct responses)
4. Test-weighting key
5. Data input

Layout of Deck Cards

Card	*Column*	*Program symbol*	*Definition*	*Range or code*
Name				
	1–80	ANAMPRB	Alphanumeric name of the problem	Any character or comment
Parameter				
	1–3	SUBJECTS	Number of subjects	$\leq$ 500
	4–6	TSTITEMS	Number of test items	$\leq$ 60
	7	ISCROP	Subject-scoring option	0 = no output 1 = punch 2 = print
	8	IBISOP	Type of item analysis	0 = no analysis 1 = product moment 2 = biserial
	9	MISSOP	Missing-data option	0 = nothing 1 = substitution of AVDATA[a] 2 = count missing cells, no insert
	10	LASEWELL	Scoring/weighting option	0 = none 1 = correcting 2 = weighting 3 = correcting and weighting

continued

Card	*Column*	*Program symbol*	*Definition*	*Range or code*
	11,12	IUPLIMT	Highest score for item on input cards	right justify
	13,14	LWLIMT	Lowest score for item on input cards	right justify
	15–18	AVDATA[a]		F4.0 (see below)
	50	ITET	Tetrachoric matrix option (only if TSTITEMS ≤ SUBJECTS)	1 = Yes (required if factor analysis is calculated)
	51–52	NF	Number of factors to be extracted	zero or blank = no factor analysis; any right-justified number ≤ 10 calls for factor analysis
	75	IDEND	ID number follows data	1 = Yes; if so, no criterion or factor analysis possible
	76	NOITEM	Suppress item-score printing	1 = Yes
	77	NORES	Suppress item-response distribution printing	1 = Yes
	78	NOFREQ	Suppress score-frequency distribution	1 = Yes
	79	IOVER	Correction for overlap	blank or 0= Henryssons's; 1= Guilford's
	80	ICRIT	External criterion score included	1 = Yes; if so, must immediately follow ID
Format				
	1–80	AFORMAT	Format describing location of ID, criterion score (if used)	

continued

Card	*Column*	*Program symbol*	*Definition*	*Range or code*
			and item responses. *ID in I format all else in F format*	$\leq$ 12 fields/card
Score card, if used				
	As specified by format, the table of correct items			
Weighting card, if used				
	As specified by format, how to weight items			
Data cards,				
	As specified by format			

---

[a] AVDATA (with a format of F4.0) is to be the inserted average value if Col. 9 (the MISSOP option) is 1. This is principally used in psychological testing or attitude inventories (where such an average value might be desired whenever an item is omitted).

Description of Output

1. The input parameters and computed metrics are all printed.
2. Subject test scores with z and t scores may be punched, printed, or neither.

Job Deck Structure

Job card
LIBRARY (SUZYQ)
LGO.
7–8–9 (EOR card)

    Name card
    Parameter card
    Format card
    Scoring card(s), if specified
    Weighting card(s), if specified
    Data cards

(Program control cards and data may be repeated for as many cycles as desired. separated each time by an EOR card)

6–7–8–9 (EOR card)

SAMPLE INPUT

```
VLORR.CH[redacted],CM136200.    SUZYQ
LIBRARY(SUZYQ)
LGO.
C10 MIDTERM EVENING DIVISION 68 MAR 26    ELIOT
02703022210401
(I10,30F2.0)
 1         4 4 3 1 1 2 1 3 2 3 4 2 3 1 3 4 3 2 4 3 2 4 4 4 3 4 3 2 3 4
 1 0 3 2 4 4 1 4 1 2 2 4 1 2 3 3 3 3 1 3 3 3 4 4 3 3 4 4 3 3 4 3 3 2 3
 1 0 4 1 6 4 4 3 3 1 2 1 4 1 2 4 2 3 1 3 4 4 4 4 3 3 4 4 1 3 3 3 3 2 4
 1 0 5 0 7 4 4 3 4 1 2 1 1 1 2 3 3 1 1 3 4 3 2 4 3 3 4 4 1 3 4 3 4 3 4
 1 0 6 3 0 1 1 3 3 2 2 2 3 2 2 3 2 3 1 3 4 3 2 4 3 2 4 3 4 4 4 3 3 2 1
 1 0 8 1 7 4 2 4 1 1 4 1 2 2 3 4 2 3 1 3 4 3 2 4 3 2 4 3 1 3 3 3 2 2 4
 1 0 9 0 9 4 4 4 1 1 4 2 3 3 3 1 2 4 4 4 4 3 1 4 4 4 4 4 3 3 4 3 3 2 4
 1 1 0 0 2 4 3 2 1 1 3 1 2 2 2 3 2 4 2 3 4 3 4 4 4 2 4 4 1 3 2 3 1 3 4
 1 1 1 0 8 4 4 4 4 2 2 1 3 1 3 4 2 3 1 3 4 4 2 2 3 2 4 4 3 3 4 3 2 3 4
 1 1 3 1 2 4 4 3 1 1 2 4 2 2 3 3 4 3 1 3 3 3 2 4 3 2 4 3 1 3 4 3 2 2 3
 1 1 4 1 1 4 4 1 1 3 4 4 1 2 1 2 3 3 2 4 4 1 2 4 3 2 4 4 3 3 3 3 2 3 3
 1 1 5 1 8 1 3 1 1 1 4 4 3 2 2 4 4 4 1 3 3 1 4 2 3 2 4 1 3 3 4 1 4 2 4
 1 1 9 0 5 4 1 3 4 1 3 1 2 2 3 3 3 3 1 3 4 3 2 4 3 2 4 4 1 3 4 3 3 3 3
 1 2 0 1 0 4 4 4 4 1 2 1 3 1 3 4 2 3 1 3 4 4 4 4 4 2 4 4 3 3 4 2 3 3 3
 1 2 2 2 8 4 4 3 1 1 4 2 3 1 2 3 2 3 1 3 4 3 4 4 3 3 4 4 1 3 4 3 3 3 4
 1 2 3 0 3 4 3 4 4 3 2 1 2 2 3 4 3 3 1 3 4 1 4 4 3 2 4 4 3 3 4 3 2 3 3
 1 2 4 2 2 4 4 3 1 1 2 1 1 1 3 4 2 1 1 3 4 1 2 4 3 2 4 4 1 4 3 3 2 3 1
 1 2 5 2 0 4 4 3 3 1 2 1 3 1 3 4 3 3 1 3 4 3 2 4 3 2 4 4 4 4 3 3 2 3 3
 1 2 7 2 3 4 1 2 1 1 4 4 1 4 3 2 2 1 4 3 4 4 4 4 3 2 4 4 3 3 4 3 3 2 4
 1 2 8 1 4 4 4 3 1 1 2 1 3 4 3 4 2 1 1 3 4 4 2 4 3 3 4 4 3 3 4 3 2 2 4
 1 3 0 1 5 4 1 4 2 1 4 4 2 2 3 2 4 3 1 3 4 3 2 4 3 2 4 3 3 4 3 3 3 3 1
 1 3 1 0 6 2 4 3 1 1 2 4 1 2 3 3 2 3 1 3 4 3 2 4 3 2 4 3 1 3 4 3 2 3 4
 1 3 2 1 3 2 1 4 1 1 4 4 2 3 3 4 4 3 1 1 4 3 2 4 3 3 4 1 1 3 3 3 2 2 3
 1 3 3 2 1 4 1 2 4 1 4 1 4 2 3 3 2 3 1 1 4 3 2 3 3 3 2 4 4 3 4 3 2 3 3
 1 3 4 2 9 4 2 3 2 2 2 1 1 2 2 4 3 4 1 3 4 3 4 4 4 2 4 3 1 4 3 3 4 3 4
 1 3 5 0 4 4 3 4 4 1 2 1 2 2 3 4 3 3 1 1 4 1 4 2 3 2 4 4 3 3 3 3 3 3 4
 1 3 6 2 7 4 4 4 3 1 4 4 1 2 2 4 3 1 1 4 3 3 2 4 3 3 4 4 3 4 4 3 3 3 3
 1 3 9 1 9 4 4 1 3 2 1 3 2 3 3 2 2 4 2 3 4 4 2 4 4 1 4 2 3 3 3 3 1 2 4
```

SAMPLE OUTPUT

```
                                                              PROGRAM WRITTEN BY BRENT M. RUTHERFORD
                                                              CONVERTED FOR CDC 6400 BY JANOS B.KOPLYAY
                                                              VERSION OF FEB.22, 1968

HOYT TECHNIQUE UTILIZING ANALYSIS OF VARIANCE TO DETERMINE TEST RELIABILITY COEFFICIENT


10 MIDTERM EVENING DIVISION 68 MAR 26    ELTOT

THIS PROBLEM HAS  27  TEST SUBJECTS

                  30  TEST ITEMS

                   2  FOR SUBJECT SCORING OPTION

                   2  FOR ITEM ANALYSIS OPTION

                   2  FOR MISSING DATA OPTION

                   1  FOR SCORING/ WEIGHTING OPTION

                   4  FOR HIGHEST ITEM SCORE

                   1  FOR LOWEST ITEM SCORE

                * 00  FOR MISSING DATA INSERT

FORMAT GIVEN
(I10,30F2.0)

ANSWER CORRECTING GIVEN
100000000 4 4 3 1 1 2 1 3 2 3 4 2 3 1 3 4 3 2 4 3 2 4 4 4 3 4 3 2 3 4

FIRST DATA CARD(S) GIVEN
100030204 4 1 4 1 2 2 4 1 2 3 3 3 3 1 3 3 3 4 4 3 3 4 4 3 3 4 3 3 2 3
```

TABLE OF ITEM RESPONSES

ITEM	-0-	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	MEAN	SD
1	0	2	2	0	23	0	0	0	0	0	3.6296	.8575
2	0	7	2	4	14	0	0	0	0	0	2.9259	1.6866
3	0	3	3	11	10	0	0	0	0	0	3.0370	.9601
4	0	13	2	5	7	0	0	0	0	0	2.2222	1.7179
5	0	20	5	2	0	0	0	0	0	0	1.3333	.3846
6	0	1	14	2	10	0	0	0	0	0	2.7778	1.0256
7	0	14	3	1	9	0	0	0	0	0	2.1852	1.9259
8	0	8	9	8	2	0	0	0	0	0	2.1481	.9003
9	0	7	15	3	2	0	0	0	0	0	2.0000	.6923
10	0	1	8	18	0	0	0	0	0	0	2.6296	.3191
11	0	1	4	9	13	0	0	0	0	0	3.2593	.7379
12	0	0	14	9	4	0	0	0	0	0	2.6296	.5499
13	0	5	0	17	5	0	0	0	0	0	2.8148	.9259
14	0	22	3	0	2	0	0	0	0	0	1.3333	.6923
15	0	3	0	21	3	0	0	0	0	0	2.8889	.5641
16	0	0	0	4	23	0	0	0	0	0	3.8519	.1311
17	0	5	0	16	6	0	0	0	0	0	2.8519	.9772
18	0	1	16	0	10	0	0	0	0	0	2.7037	1.0627
19	0	0	3	1	23	0	0	0	0	0	3.7407	.4302
20	0	0	0	22	5	0	0	0	0	0	3.1852	.1567
21	0	1	17	8	1	0	0	0	0	0	2.3333	.3846
22	0	0	1	0	26	0	0	0	0	0	3.9259	.1481
23	0	2	1	6	18	0	0	0	0	0	3.4815	.7977
24	0	11	0	13	3	0	0	0	0	0	2.2963	1.2934
25	0	0	0	21	6	0	0	0	0	0	3.2222	.1795
26	0	0	1	10	16	0	0	0	0	0	3.5556	.3333
27	0	1	1	25	0	0	0	0	0	0	2.8889	.1795
28	0	2	11	11	3	0	0	0	0	0	2.5556	.6410
29	0	0	11	16	0	0	0	0	0	0	2.5926	.2507
30	0	3	0	10	14	0	0	0	0	0	3.2963	.9088

continued

```
TABLE OF SUBJECT TEST SCORES

ID NUMBER              SCORE          Z SCORE         T SCORE
        100030204      16.00          -.787675        42.12325
        100040106      19.00          .098459         50.98459
        100050007      20.00          .393838         53.93838
        100060300      18.00          -.196919        48.03081
        100080107      22.00          .984594         59.84594
        100090009      16.00          -.787675        42.12325
        101000002      17.00          -.492297        45.07703
        101010008      23.00          1.279973        62.79973
        101030102      21.00          .689216         56.89216
        101040101      16.00          -.787675        42.12325
        101050108      13.00          -1.673810       33.26190
        101090005      21.00          .689216         56.89216
        102000100      20.00          .393838         53.93838
        102020208      21.00          .689216         56.89216
        102030003      20.00          .393838         53.93838
        102040202      22.00          .984594         59.84594
        102050200      24.00          1.575351        65.75351
        102070203      16.00          -.787675        42.12325
        102080104      24.00          1.575351        65.75351
        103000105      16.00          -.787675        42.12325
        103010006      24.00          1.575351        65.75351
        103020103      15.00          -1.083054       39.16946
        103030201      19.00          .098459         50.98459
        103040209      16.00          -.787675        42.12325
        103050004      18.00          -.196919        48.03081
        103060207      15.00          -1.083054       39.16946
        103090109      12.00          -1.969188       30.30812
```

continued

TABLE OF ITEM TEST SCORES

ITEM NUMBER	SCORE
1	23.00
2	14.00
3	11.00
4	13.00
5	20.00
6	14.00
7	14.00
8	8.00
9	15.00
10	18.00
11	13.00
12	14.00
13	17.00
14	22.00
15	21.00
16	23.00
17	16.00
18	16.00
19	23.00
20	22.00
21	17.00
22	26.00
23	18.00
24	3.00
25	21.00
26	16.00
27	25.00
28	11.00
29	16.00
30	14.00

continued

```
FREQUENCY DISTRIBUTION OF TEST SCORES

FREQUENCY      SCORE      ZSCORE       TSCORE

    3            24       1.57535       65.7535

    1            23       1.27997       62.7997

    2            22        .98459       59.8459

    3            21        .68922       56.8922

    3            20        .39384       53.9384

    2            19        .09846       50.9846

    2            18       -.19692       48.0308

    1            17       -.49230       45.0770

    6            16       -.78768       42.1232

    2            15      -1.08305       39.1695

    0            14      -1.37843       36.2157

    1            13      -1.67381       33.2619

    1            12      -1.96919       30.3081

ITEM ANALYSIS TABLE WITH INTERNAL TEST SCORE

STUDENT#S T TESTS HAVE       25 DEGREES OF FREEDOM

 ITEM     POINT           VARIANCE       T TEST   IN UPPER       IN LOWER        BISERIAL      VARIANCE       X50          BETA
           BISERIAL     ACCOUNTED FOR              DICHOTOMY      DICHOTOMY                      ACCOUNTED FOR

   1       .1464           .0214          .7402   N=     23      N=      4        .2208         .0488       -4.7304        .2264
 OVERLAP   .0419           .0018          .2098   P=  .8519      Q=  .1481        .0602         .0036      -17.3617        .0603

   2       .3496           .1222         1.4655   N=     14      N=     13        .4301         .1850        -.1080        .4764
 OVERLAP   .2107           .0444         1.0778   P=  .5185      Q=  .4815        .2554         .0652        -.1818        .2642

   3       .5597           .3132         3.3767   N=     11      N=     16        .6953         .4834         .3369        .9673
 OVERLAP   .4474           .2001         2.5010   P=  .4074      Q=  .5926        .5511         .3037         .4250        .6604

   4       .0074           .0001          .0372   N=     13      N=     14        .0092         .0001        5.0742        .0092
 OVERLAP  -.1388           .0193         -.7008   P=  .4815      Q=  .5185       -.1742         .0303         .2666       -.1769

   5       .2459           .0605         1.2685   N=     20      N=      7        .3265         .1066       -1.9774        .3454
 OVERLAP   .1193           .0142          .6008   P=  .7407      Q=  .2593        .1550         .0240       -4.1667        .1569

   6       .5281           .2788         3.1091   N=     14      N=     13        .6497         .4221        -.0715        .8547
 OVERLAP   .4089           .1672         2.2401   P=  .5185      Q=  .4815        .4985         .2485        -.0931        .5751

   7       .5281           .2788         3.1091   N=     14      N=     13        .6497         .4221        -.0715        .8547
 OVERLAP   .4089           .1672         2.2401   P=  .5185      Q=  .4815        .4985         .2485        -.0931        .5751

   8       .2360           .0557         1.2143   N=      8      N=     19        .3059         .0936        1.7493        .3213
 OVERLAP   .1035           .0107          .5204   P=  .2963      Q=  .7037        .1307         .0171        4.0949        .1318

   9      -.1795           .0322         -.9122   N=     15      N=     12       -.2215         .0491        -.6307       -.2272
 OVERLAP  -.0332           .0011         -.1663   P=  .5556      Q=  .4444       -.3921         .1537        -.3564       -.4262

  10       .3074           .0945         1.6154   N=     18      N=      9        .3912         .1530       -1.1012        .4250
 OVERLAP   .1741           .0303          .8838   P=  .6667      Q=  .3333        .2178         .0474       -1.9779        .2231

  11       .1859           .0346          .9462   N=     13      N=     14        .2288         .0523         .2030        .2350
 OVERLAP   .0390           .0015          .1951   P=  .4815      Q=  .5185        .0444         .0020        1.0449        .0445

  12       .2603           .0678         1.3480   N=     14      N=     13        .3203         .1026        -.1450        .3381
 OVERLAP   .1169           .0134          .5837   P=  .5185      Q=  .4815        .1390         .0193        -.3340        .1404

  13       .3617           .1308         1.9397   N=     17      N=     10        .4538         .2059        -.7291        .5092
 OVERLAP   .2287           .0523         1.1747   P=  .6296      Q=  .3704        .2831         .0802       -1.1687        .2952
 14        .4688          .2197          2.6534  N=     22    N=      5       .6691        .4477     -1.3390       .9003
OVERLAP    .3720          .1384          2.0039  P=  .8148    Q=  .1852       .5272        .2779     -1.6996       .6203

 15        .3486          .1215          1.8597  N=     21    N=      6       .4776        .2281     -1.6013       .5436
OVERLAP    .2342          .0549          1.2046  P=  .7778    Q=  .2222       .3173        .1007     -2.4103       .3346

 16        .3034          .0920          1.5918  N=     23    N=      4       .4574        .2092     -2.2837       .5144
OVERLAP    .2039          .0416          1.0412  P=  .8519    Q=  .1481       .3041        .0925     -3.4349       .3192

 17        .0529          .0028           .2651  N=     16    N=     11       .0658        .0043     -3.5614       .0659
OVERLAP   -.0919          .0085          -.4616  P=  .5926    Q=  .4074      -.1176        .0138     -1.9915      -.1184

 18        .3025          .0915          1.5870  N=     16    N=     11       .3758        .1412      -.6233       .4056
OVERLAP    .1629          .0265           .8256  P=  .5926    Q=  .4074       .1987        .0395     -1.1790       .2027

 19        .0523          .0027           .2619  N=     23    N=      4       .0789        .0062    -13.2452       .0791
OVERLAP   -.0526          .0028          -.2635  P=  .8519    Q=  .1481      -.0824        .0068    -12.6831      -.0826

 20        .3540          .1253          1.8923  N=     22    N=      5       .5052        .2553     -1.7733       .5855
OVERLAP    .2478          .0614          1.2789  P=  .8148    Q=  .1852       .3502        .1226     -2.5584       .3739

 21        .2232          .0498          1.1447  N=     17    N=     10       .2800        .0784     -1.1817       .2917
OVERLAP    .0823          .0068           .4130  P=  .6296    Q=  .3704       .0997        .0099     -3.3171       .1002

 22       -.0197          .0004          -.0984  N=     26    N=      1      -.0451        .0020    -39.6439      -.0452
OVERLAP    .0361          .0013           .1806  P=  .9630    Q=  .0370      -.1751        .0306    -10.2209      -.1778

 23        .2601          .0677          1.3471  N=     18    N=      9       .3310        .1096     -1.3014       .3508
OVERLAP    .1242          .0154           .6260  P=  .6667    Q=  .3333       .1545        .0239     -2.7881       .1564

 24        .1774          .0315           .9011  N=      3    N=     24       .2888        .0834      4.2265       .3017
OVERLAP    .0856          .0073           .4295  P=  .1111    Q=  .8889       .1364        .0186      8.9488       .1377

 25        .0268          .0007           .1341  N=     21    N=      6       .0367        .0013    -20.8163       .0368
OVERLAP   -.0956          .0091          -.4801  P=  .7778    Q=  .2222      -.1341        .0180     -5.7016      -.1354

 26        .1891          .0357           .9627  N=     16    N=     11       .2349        .0552      -.9972       .2416
OVERLAP    .0447          .0020           .2237  P=  .5926    Q=  .4074       .0520        .0027     -4.5033       .0521

 27        .1845          .0340           .9384  N=     25    N=      2       .3383        .1144     -4.2774       .3595
OVERLAP    .1083          .0117           .5449  P=  .9259    Q=  .0741       .1959        .0384     -7.3867       .1998

 28        .5597          .3132          3.3767  N=     11    N=     16       .6953        .4834       .3369       .9673
OVERLAP    .4474          .2001          2.5010  P=  .4074    Q=  .5926       .5511        .3037       .4250       .6604

 29        .3025          .0915          1.5870  N=     16    N=     11       .3758        .1412      -.6233       .4056
OVERLAP    .1629          .0265           .8256  P=  .5926    Q=  .4074       .1987        .0395     -1.1790       .2027

 30       -.0074          .0001          -.0372  N=     14    N=     13      -.0092        .0001     -5.0742      -.0092
OVERLAP    .1388          .0193           .7008  P=  .5185    Q=  .4815      -.1919        .0368      -.2419      -.1956

SUMMARY OF ITEM METRICS. AVERAGES

  0        .2439          .0924          1.3342  N=     17    N=     10       .3205        .1562     -3.1993       .3777
OVERLAP    .1446          .0452           .7652  P=  .6222    Q=  .3778       .1551        .0806     -2.3941       .1725

SUMMARY OF ITEM METRICS. STANDARD DEVIATIONS

  0        .1845          .0956          1.0720  N=      5    N=      5       .2351        .1523      8.3522       .3084
OVERLAP    .1587          .0619           .8622  P=  .1919    Q=  .1919       .2420        .0967      4.8284       .2725

  TEST P =  .6222222
```

```
SUMMARY OF ANALYSIS OF VARIANCE


SOURCE OF          DEGREES OF         SUM OF              MEAN
VARIANCE           FREEDOM            SQUARES             SQUARES            F RATIO

BETWEEN
INDIVIDUALS              26              9.933               .3821            1.89990

BETWEEN
ITEMS                    29             28.844               .9946            4.94621


RESIDUAL                754            151.622               .2011


TOTAL                   809            190.400
SPECIFICITY FACTOR=    .286698

STANDARD ERROR OF MEASUREMENT =  2.414876

COEFFICIENT OF TEST RELIABILITY =    .473656

SCORE MEAN =   18.6667

SCORE VARIANCE =  11.46154

SCORE STANDARD DEVIATION =   3.38549

SUM SUBJECTS# TOTAL SCORES =         504

SUBJECTS# TOTAL SCORES SQUARED =        9706

ITEMS# TOTAL SCORES SQUARED =      9246

TOTAL SUM OF SQUARED CELLS =         504

NUMBER OF MISSING DATA CELLS =          0

T=   -.04282 SKEW NOT SIGNIFICANT AT .05 LEVEL

T=   -.86974 KURTOSIS NOT SIGNIFICANT AT .05 LEVEL




          THAT WHICH WOULD KINDLE THE LIGHTNING

MUST FOR A LONG TIME BE A CLOUD.

                                   .... NIETZSCHE
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 1.832 seconds for central-processor time and 20.993 seconds for peripheral-processor time with a memory useage of 136,200 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—SUZYQ

pages
1,2 Identification & Abstract
3–5 User Instructions
7–14 I/O
15 Cost—Contents

DESCRIPTIVE TITLE	Multivariate Analysis of Variance-Covariates, Hotelling's T
CALLING NAME	MULCVR NUCC080
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Anonymous; Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

MULCVR performs an analysis on a number (three or more) of measurements taken about an arithmetic mean (the "origin"), together with arithmetic means as specified on the Control Cards or by Hotelling's T Test.

REFERENCES

Rao, C.R., *Advanced Statistical Methods in Biometric Research* (John Wiley & Sons, Inc., New York, 1952), pp.239–248, 258–266.

Cooley, W.W., and Lohnes, P.R., *Multivariate Procedures for the Behavioral Sciences* (John Wiley & Sons, Inc., New York, 1963).

/

USER INSTRUCTIONS

Description of Input Data

This program can process more than one problem. Decks for each problem are placed one after the other. Each problem deck has the following form.

Card 1: Problem Card

Columns	*Contents*
1– 2	Problem number (numeric)
3– 4	Number of groups (N GROUPS) (≤ 10)
5– 6	Total number of variables and covariates [M=NVAR+NCVR(≤ 30)]
7– 8	Number of variables (NVAR) (≤ 30)
9–10	Number of covariates (NCVR) (≤ 29)
11–15	Total sample size (NTOTAL)—the sum of the sample sizes for each individual group
16	1, if Hotelling's test is to be performed = IFHT 0, if analysis of variance or covariance is desired = IFHT
17	1, if sums of squares and crossproducts matrix is to be printed 0, if not desired
18	1, if the variance–covariance matrix for each group is desired 0, if not desired

If there are no covariates, NCVR = 0, making NVAR and M equal.

For Hotelling's T

IFHT = 1. Number of variables is zero (NVAR = 0), all the variables being specified as covariates. Therefore, total variates plus covariates is simply equal to the number of variables in the single group involved: N GROUPS = 1, NVAR = 0, and NCVR = number of variables. Total sample size and the first entry (the only one) on the replication card should be equal.

continued

Card 2: Replication Card—Group Sizes

Columns	*Contents*
1– 3	Number in group 1
4– 6	Number in group 2
7– 9	Number in group 3
.	.
.	.
.	.
28–30	Number in group 10

If there are less than 10 groups, the rest of the card after the last group may be left blank.

Card 3: Variable-Format Card

Columns	*Contents*
1–72	Data format—FORTRAN format specifications (enclosed in parentheses) in standard form. *Example*: (F4.2, 3F6.1)

Data Cards

These cards contain all the data for this problem.

Description of Output

The program produces different output, depending on whether or not Hotelling's T test was performed. Following descriptions are prefixed with IFHT = 1 for output from the Hotelling's option and IFHT = 0 for output from the alternative option. No prefix indicates that the output is generated regardless of choice of this option.

For each group, the sample size, a general summary, the crossproduct matrix, and the variance–covariance dispersion matrix are printed, labeled as such. The general summary includes, for each variable, the mean, the standard deviation, the standard error of the mean, the unbiased variance, the sum of the raw data, and the sum of squares of the raw data.

For each problem, the "within matrix" and the "total matrix" are printed. The first is the overall, within-groups, variance–covariance matrix. The second is the overall, total, variance–covariance matrix.

continued

IFHT = 0. For each variable, the F ratios and degrees of freedom are reported. Wilk's lambda and its associated chi square with degrees of freedom are given.

IFHT = 1. Hotelling's T and the appropriate degrees of freedom for it are printed.

Limitations

Maximum values of parameters have been indicated above. They are N GROUPS $\leq$ 10; NVAR $\leq$ 30; NCVR $\leq$ 29; NVAR + NCVR $\leq$ 30. There is no limit to the number of observations (NTOTAL) other than the space provided on the problem and replication cards for punching the sample sizes.

SAMPLE INPUT

```
VLORR,CH[redacted],CM50400.    MULCVR
LIBRARY(MULCVR,DEISP)
LGO.
 1 3 4 4 0  400011
107135158
(5X,3F4.2,5F5.2)
T1316 630 660 740 2.87
T1072 610 700 660 2.37
T0415 630 660 580 3.00
T0034 660 630 690 3.00
T0837 690 790 700 2.52
T1334 570 570 580 2.25
T0893 760 750 800 3.37
T1261 690 680 700 2.71
T0046 650 620 630 2.12
T1351 490 640 500 2.51
T0518 460 560 480 3.37
T0436 610 510 720 2.57
T0509 630 620 580 2.75
T0062 430 650 570 2.62
T0319 520 600 540 3.10
T1043 580 540 620 2.25
T0488 710 580 620 3.37
T0731 650 700 650 3.42
T1118 580 650 540 2.28
T0119 620 610 570 3.00
T1445 600 510 570 3.03

                 .
                 .
                 .

S0978 650 650 700 2.13
S0981 650 640 520 2.76
S0586 610 650 690 3.13
S0982 600 590 660 2.50
TR2   610 570 610 2.75
TR3   500 580 500 2.96
TR4   650 600 540 2.38
TR7   570 480 520 3.50
TR11  590 570 550 3.13
TR15  520 600 670 2.63
TR19  590 630 650 2.50
TR21  630 450 640 1.97
MA1   550 630 620 2.13
MA5   660 610 670 1.35
MA6   520 700 540 1.38
MA8   550 510 610 2.50
MA9   430 580 490 1.83
MA10  610 650 470 2.50
MA12  550 650     2.13
MA13  540 700 650 2.38
MA14  610 600 660 2.25
MA23  580 580 640 0.75
MA16  700 610 720 2.75
MA17  520 540 460 2.63
MA18  720 730 730 3.63
MA20  520 680 520 1.88
MA22  580 690     2.63
```

SAMPLE OUTPUT

```
GROUP  1SS 107  VARIABLE       MEAN         STANDARD       STANDARD       UNBIASED        SUM OF        SUM OF SOS
                                            DEVIATION   ERROR OF MEAN     VARIANCE        RAW DATA       RAW DATA
                   1          5.4804          .8998          .0870           .8097        586.4000        3299.52
                   2          5.7935          .8709          .0842           .7585        619.9000        3671.77
                   3          5.7000         1.0456          .1011          1.0932        609.9000        3592.31
                   4          2.3816          .5744          .0555           .3299        254.8300         641.87
```

```
CROSS PRODUCTS FOR GROUP 1  PROBLEM  1
ROW 1
      3299.52
ROW 2
      3441.36       3671.77
ROW 3
      3414.86       3584.85       3592.31
ROW 4
      1426.19       1497.33       1481.75       641.87
```

```
VARIANCE COVARIANCE - DISPERSION MATRIX-GROUP 1  PROBLEM  1
ROW 1
        31.13
ROW 2
        32.47         34.64
ROW 3
        32.22         33.82         33.89
ROW 4
        13.45         14.13         13.98          6.06

.   .   .         .

.   .   .         .

.   .   .         .
```

continued

```
VARIABLE  FRATIO  DEGREES OF FREEDOM
    1     22.4284      (  2.397)
    2     15.0420      (  2.397)
    3      7.4628      (  2.397)
    4      5.3614      (  2.397)


WILKS LAMBDA=   .824130     7.679070E+01=CHISQUARE WITH   8DEGREES OF FREEDOM




WITHIN MATRIX
ROW 1
       216.52         86.56        173.06         71.22
ROW 2
        86.56        228.23         95.58         60.45
ROW 3
       173.06         95.58        421.12         85.31
ROW 4
        71.22         60.45         85.31        157.43




TOTAL MATRIX
ROW 1
       240.99        106.56        186.45         76.86
ROW 2
       106.56        245.53        103.69         63.39
ROW 3
       186.45        103.69        436.95         93.40
ROW 4
        76.86         63.39         93.40        161.68


 .   .   .           .

 .   .   .           .

 .   .   .           .


 HOTELLINGS T=   2.708697E+04 DISTRIBUTED AS F(  1,39

 VALUE OF HOTELLING≠S T MAY BE INCORRECT.
 THE PROBLEM IS UNDER INVESTIGATION AS OF MARCH 1968.
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 3.383 seconds for central-processor time and 17.992 seconds for peripheral-processor time with a memory useage of 50,400 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—MULCVR

pages

1	Identification & Abstract
3–5	User Instructions
7–9	I/O
11	Cost—Contents

DESCRIPTIVE TITLE	"Book-Type" Indexing Program
CALLING NAME	INDEXER NUCC166
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	James Ibers, Chemistry Department, Northwestern University (original programming design) Donald Dillaman, Vogelback Computing Center, Northwestern University (CDC 6400 conversion) Lorraine Borman, Vogelback Computing Center, Northwestern University (program writeup)
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

Purpose and General Description. INDEXER is a FORTRAN program that will produce a "book-type" index, sorting and printing under a major heading and two subheadings.

Data Input
The program sorts on 136 columns.

Format for data cards is
major heading/first subheading/second subheading/page number

An * in column 80 of the first card of a data item indicates that information is continued onto a second card.

USER INSTRUCTIONS

Data Format—The following input

```
ABSORPTION/AS A SOURCE OF SYSTEMATIC ERROR//68
ABSORPTION/COEFFICIENT/DEFINED//67
```

would appear as the following output

```
ABSORPTION
    AS A SOURCE OF SYSTEMATIC ERROR 68
    COEFFICIENT
         DEFINED 67
```

Program Control Cards

	Columns		
Card 1:	1-80		Alphanumeric information (printed as a separate identification page of output)
Card 2:			Control Information:
	5	0	Sort desired
		1	Sorted data are on tape Request card must then be used, e.g., REQUEST (TAPE 1) HANG DATA TAPE
	10	0	No punched output
		1	Punched output of sorted input data
	15	0	No printed output
		1	Printed output

Description of Output

Output consists of one page of identification, a listing of the input information, a listing of the sorted (alphabetized) input, and a final listing by header, subheader, etc. The final listing is suitable for photo-offset printing.

Job Deck Structure

```
Job card
LIBRARY (INDEXER)
LGO.
7-8-9
    ID Card
    Control Card
    Data Cards
6-7-8-9
```

SAMPLE INPUT

```
VLOBR.CH[redacted].CM113200.   INDEXER
LIBRARY(INDEXER)
LGO.
THIS IS A TEST FOR THE BLESSED SYSTEM
    0   0   4
DISTILLATION/TRAP-TC-TRAP//7
DISTILLATION/FRACTIONAL/VACUUM LINE//57-60
DISTILLATION/CODISTILLATION//60
DISTILLATION/FRACTIONAL/INERT ATMOSPHERE//2
JOINTS/FLANGE,,10
BOND LENGTH/*SEE ALSO SPECIFIC COMPOUNDS//
ABSORPTION/DEFINED// 67
ACCURACY/OF BOND LENGTHS//63
ACCURACY/*SEE PRECISION//
ACTIVATED PROCESS//129
ACID SALTS// 19
ALPHA HELIX //258
AMINO ACIDS/CYSTINE//166
AMMINES//321
AMMONIA//221
BASE PAIRS//171
ABSORPTION/COEFFICIENT/DEFINED// 67
ABSORPTION/COEFFICIENT/RELATION TO CROSS SECTION//155
AMMONIA//262
AMMONIUM/ION/DISTORTIONS OF//227
AMMONIUM/ION/DISTORTIONS OF//229
ASPRIN, POTASSIUM ACID SALT//181
ABSORPTION/AS A SOURCE OF SYSTEMATIC ERROR// 68
BASE PAIRS/A-U//174
BASE PAIRS/HYDROGEN BONDING/CONFIGURATIONAL ENERGY//176
BASE PAIRS/HYDROGEN BONDING/CRICK-WATSON SCHEME//151
BENZENE-I2 COMPLEX// 3
```

continued

SAMPLE OUTPUT

```
THIS IS A TEST FOR THE BLESSED SYSTEM
   0     0     4    -0    -0    -0    -0    -0    -0    -0    -0    -0    -0    -0    -0    -0


 INPUT INFORMATION


DISTILLATION/TRAP-TC-TRAP//  7
DISTILLATION/FRACTICNAL/VACUUM LINE//57-60
DISTILLATION/CODISTILLATION// 60
DISTILLATION/FRACTICNAL/INERT ATMOSPHERE//  2
JOINTS/FLANGE// 10
BOND LENGTH/*SEE ALSO SPECIFIC COMPOUNUS//
ABSCRPTION/DEFINED// 67
ACCURACY/OF BOND LENGTHS// 63
ACCURACY/*SEE PRECISION//
ACTIVATED PROCESS//129
ACIC SALTS// 19
ALPHA HELIX //258
AMINO ACIDS/CYSTINE//166
AMMINES//321
AMMCNIA//221
BASE PAIRS//171
ABSCRPTION/COEFFICIENT/DEFINED// 67
ABSCRPTION/COEFFICIENT/RELATION TO CROSS SECTION//155
AMMCNIA//262
AMMCNIUM/ION/DISTORTIONS OF//227
AMMCNIUM/ION/DISTORTIONS OF//229
ASPRIN, POTASSIUM ACID SALT//181
ABSCRPTION/AS A SOURCE OF SYSTEMATIC ERROR// 68
BASE PAIRS/A-U//174
BASE PAIRS/HYDROGEN BONDING/CONFIGURATIONAL ENERGY//176
BASE PAIRS/HYDROGEN BONDING/CRICK-WATSON SCHEME//153
BENZENE-I2 COMPLEX//  3


ALPHABETIZED INFORMATION


ABSCRPTION/AS A SOURCE OF SYSTEMATIC ERROR// 68
ABSCRPTION/COEFFICIENT/DEFINED// 67
ABSCRPTION/COEFFICIENT/RELATION TO CROSS SECTION//155
ABSCRPTION/DEFINED// 67
ACCURACY/OF BOND LENGTHS// 63
ACCURACY/*SEE PRECISION//
ACIC SALTS// 19
ACTIVATED PROCESS//129
ALPHA HELIX //258
AMINO ACIDS/CYSTINE//166
AMMINES//321
AMMCNIA//221
AMMCNIA//262
AMMCNIUM/ION/DISTORTIONS OF//227
AMMCNIUM/ION/DISTORTIONS OF//229
ASPRIN, POTASSIUM ACID SALT//181
BASE PAIRS/A-U//174
BASE PAIRS/HYDROGEN BONDING/CONFIGURATIONAL ENERGY//176
BASE PAIRS/HYDROGEN BONDING/CRICK-WATSON SCHEME//153
BASE PAIRS//171
BENZENE-I2 COMPLEX//  3
BOND LENGTH/*SEE ALSO SPECIFIC COMPOUNUS//
DISTILLATION/CODISTILLATION// 60
DISTILLATION/FRACTICNAL/INERT ATMOSPHERE//  2
DISTILLATION/FRACTICNAL/VACUUM LINE//57-60
DISTILLATION/TRAP-TC-TRAP//  7
JOINTS/FLANGE// 10
```

continued

```
ABSORPTION
    AS A SOURCE OF SYSTEMATIC ERROR  68
    COEFFICIENT
         DEFINED  67
         RELATION TO CROSS SECTION 155
    DEFINED  67
ACCURACY
    OF BOND LENGTHS  63
    *SEE PRECISION
     .
     .
     .
AMMONIA 221 262
AMMONIUM
    ION
         DISTORTIONS OF 227 229
ASPRIN, POTASSIUM ACID SALT 181



BASE PAIRS
    A-U 174
    HYDROGEN BONDING
         CONFIGURATIONAL ENERGY 176
         CRICK-WATSON SCHEME 153
     KBASE PAIRS  171

BENZENE-I2 COMPLEX   3
BOND LENGTH
    *SEE ALSO SPECIFIC COMPOUNDS



DISTILLATION
    CODISTILLATION  60
    FRACTIONAL
         INERT ATMOSPHERE   2
         VACUUM LINE 57-
    TRAP-TO-TRAP   7


JOINTS
    FLANGE  10
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 4.921 seconds for central-processor time and 28.337 seconds for peripheral-processor time with a memory useage of 113,200 words. Chargeable computer time was $1.67.

Charge to user = computer time + postage and handling + network overhead
= $1.67 + $15.00 + network overhead
= $16.67 + network overhead

CONTENTS—INDEXER

pages

1 Identification & Abstract
3 User Instructions
5–7 I/O
9 Cost—Contents

DESCRIPTIVE TITLE	FORTRAN Program for Evaluating Internal Consistency and Single-Factoredness in Sets of Multilevel Attitude Items
CALLING NAME	ATTANAL NUCC048
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Donald G. Morrison, Council for Intersocietal Studies, Northwestern University Donald T. Campbell, Department of Psychology, Northwestern University Leroy Wolins, Iowa State University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

ATTANAL is a FORTRAN IV program for evaluating internal consistency and single-factoredness in sets of multilevel attitude (scale) items. The user may test the assumption that responses summarized in single scores reliably refer to a common trait, attitude, or factor being measured.

The analytical method employed avoids the Guttman unidimensionality requirement commonly associated with a reproducibility coefficient. Arbitrary or chance levels of reproducibility as well as singular tests of significance are replaced by measures of high internal consistency, reliability, and single-factoredness. Dichotomously scored items are replaced by multilevel responses, thus reducing the occurrence of irrelevant difficulty factors among the intercorrelation of items.

continued

The program operates on the data cards containing one-digit scores for each item; these are converted from response language to a scoring language to emphasize the significance of large scores. Separate analysis of pro and con items minimizes the effects of response-set and direction-of-wording effects. The polar-choice format of responses eliminates ambiguity of response effects and allows attitudes to be located on dimensions anchored by positive statements at either pole.

The program produces (for each item and the total set) the means, standard deviations, and a table of intercorrelations among items and sum. Using the Spearman—Brown Corrected Split-Half Method of Reliability, the program then produces a Kuder—Richardson coefficient of reliability based on item variances proportional to the number of items scored.

A modified factor-analysis procedure is applied to the data to obtain a test of single-factoredness. Using the intercorrelations among items, the program approximates optimal factor loadings and produces a commonality estimate (h^2) for each factor. A convergent solution is acceptable only if there are no negative factor loadings. If no convergent solution is found within 20 iterations, the program halts and prints the last iteration.

The interitem correlation matrix, the residuals matrix, as well as the mean and sigma for residuals is also reported. A Lawley chi-square test of significance is then applied to residuals, and the program produces a listing of factor loadings, the residuals matrix, and the Lawley chi-square with appropriate degrees of freedom. In addition, the program computes an index that purports to measure the relative closeness of each measure to single-factoredness; this index should approach 1.0 in single-factoredness tests.

REFERENCE

Morrison, D.G., Campbell, D.T., and Wolins, L., "A FORTRAN Program for Evaluating Consistency and Single-Factoredness in Sets of Multilevel Attitude Items," Northwestern Univ. Vogelback Computing Ctr. (1965; revised 1967).

USER INSTRUCTIONS

Data Format Regulations

A. Several separate sets of data can be run by following one set of control cards and data with another set for as many sets as desired. Up to (47) items may be correlated and used in the analysis. There is no limit to the number of subjects. Each item in the scale must be classed as either A-positive (Pro-) or B-positive (Con-) for certain analyses.

B. Control Cards are to be punched as follows.

1. Problem Cards

Columns	*Name*	*Contents*
1- 2	ITEM	number of items in scale
3- 5	NOSUBJ	number of subjects
6- 7	NOXTR	number of extra variables to enter correlation analysis only
8-12	blank	
	The following	columns contain 1 if item is A positive 0 if item is B positive
13	first item	
14	second item	
15	third item	
⋮	⋮	
59	47th item (if used)	

2. Title Card

Columns 1-53, which may contain any alphanumeric information.

This is used to title the output.

3. Variable-Format Card

The format card specifies the column locations of the data. It is best illustrated by example: for a typical 8-item scale (10 X, 8 F 1.0, 2 F 2.0, F 3.0, 5 F 1.0), which means:

a. skip the first 10 columns (10 X)
b. take the 8 items from columns 11-18 (8 F 1.0)
c. A-positive total in columns 19-20 } (2 F 2.0)
   B-positive total in columns 21-22 }

continued

d. grand total in columns 23, 24, 25 (F 3.0)
e. five extra items in columns 26-30 (5 F 1.0) to enter correlation analysis only.

C. Data-Card Preparation

Data cards should be prepared in the following manner.

1. The user should use the first group of columns for identification of the subject and any other information that would be useful to have with the data cards. This group of columns may be as large as is needed. The variable-format card will contain instructions to skip these columns on reading the data cards. For example, for a 10-column I-D, the variable format will begin (10X . . .). This information is not necessary so A may be absent.

2. The items on the scale follow next and take up as many columns as necessary.

3. The next three items are

   a. the sum of the A-positive scores;
   b. the sum of the B-positive scores;
   c. the sum of all the scores for that subject.

4. Next are any other measurements that may be desired. These may be entered into the analysis of correlation, mean, and standard deviation without disturbing the item analysis of the elements of Part 2.

D. Card Order

1. NUCC system cards

2. Control cards

   a. problem card
   b. title card
   c. format card

3. Data cards

(2 and 3 above may be repeated for other sets of data as required.)

SAMPLE INPUT

```
VLCRR.              .CM45700.   ATTANAL
LIBRARY(ATTANAL)
LGO.
08072        10010011
               ENGINEERING MANAGEMENT   J. UTTERBACK
(      6X,8F1.0,2F2.0,F3.1)
022   434444431416304
022   444343441515301
022   444343441515300
022   433443241314272
022   044344441611274
022   434443141413272
022   334341331113241
022   433344141412262
022   313344441214262
022   343344131411250
022   334334241511262
022   334334241511262
022   323334231211232
022   413431440915242
022   423334131211242
022   344441141312252
022   330330340712192
022   344341231212242
022   334144141509241
022   313443231013234
022   434321241211234

                  .
                  .
                  .

022   132413110907164
022   233132121007171
022   132322231008162
022   123421130408174
022   103330200309123
022   141214231206180
022   122233220908172
022   120314210707142
022   024112131103144
022   20121313070613
022   131401010605113
022   031400010504090
022   113320220608144
022   030100300304073
022   124114111104152
022   033200200604104
022   120300320407110
022   111321100307102
022   120232110507122
022   110400100601072
022   110112100304072
022   010211200205070
022   443003001004142
022   000100000001010
022   000000110101024
022   110000010201034
```

SAMPLE OUTPUT

```
0807201   22  ENGINEERING MANAGEMENT   J. UTTERBACK       01100101

NUMBER OF VARIABLES =  11

NUMBER OF SUBJECTS IN THIS GROUP =     72
VARIABLE    MEAN   STD. DEV. VARIANCE     SUM     SUM OF SQS.
 ITEM01     1.903    1.416    2.004    137.00           403.00
 ITEM02     2.556    1.255    1.574    184.00           582.00
 ITEM03     2.333    1.538    2.366    168.00           560.00
 ITEM04     2.569    1.161    1.347    185.00           571.00
 ITEM05     2.278    1.567    2.457    164.00           548.00
 ITEM06     2.153    1.526    2.328    155.00           499.00
 ITEM07     1.875    1.186    1.407    135.00           353.00
 ITEM08     2.333    1.404    1.972    168.00           532.00
 A POS.     9.444    3.845   14.786    680.00          7472.00
 B POS.     8.556    3.623   13.124    616.00          6202.00
 GRAND     18.242    6.685   44.689   1313.40         27131.54
CORRELATION MATRIX.

R MAT   SECTION  1


  VAR          ITEM01 ITEM02 ITEM03 ITEM04 ITEM05 ITEM06 ITEM07 ITEM08 A POS. B POS. GRAND
ITEM01          1.000   .174   .474   .197   .526   .183   .118   .548   .507   .733   .692
ITEM02           .174  1.000   .246   .089   .264   .190   .274   .245   .567   .325   .500
ITEM03           .474   .246  1.000   .105   .516   .224   .062   .613   .765   .492   .710
ITEM04           .197   .089   .105  1.000   .020   .069   .216   .202   .195   .453   .360
ITEM05           .526   .264   .516   .020  1.000   .212   .307   .604   .570   .774   .747
ITEM06           .183   .190   .224   .069   .212  1.000   .143   .265   .620   .260   .496
ITEM07           .118   .274   .062   .216   .307   .143  1.000   .195   .229   .590   .447
ITEM08           .548   .245   .613   .202   .604   .265   .195  1.000   .765   .636   .784
A POS.           .507   .567   .765   .195   .570   .620   .229   .765  1.000   .600   .900
B POS.           .733   .325   .492   .453   .774   .260   .590   .636   .600  1.000   .887
GRAND            .692   .500   .710   .360   .747   .496   .447   .784   .900   .887  1.000
```

continued

```
0807201   22  ENGINEERING MANAGEMENT   J. UTTERBACK            01100101
                                        RELIABILITY STUDY


                    SPLIT-HALF RELIABILITY=  .750

                    KUDER-RICHARDSON FOR TOTAL =  .748

                    KUDER-RICHARDSON FOR A POS. TOTAL=  .726

                    KUDER-RICHARDSON FOR B POS. TOTAL=  .447

INFERED AVERAGE INTER-ITEM CORRELATION


                    FROM SPLIT-HALF     .273

                    FROM KUDER-RICHARDSON(TOTAL)    .270

                    FROM KUDER-RICHARDSON(A POS)    .399

                    FROM KUDER-RICHARDSON(B POS)    .168
A+A+  AVE.=  .246
B+B+  AVE.=  .275
A+B+  AVE.=  .307
TOTAL AVE.=  .287

CORRECTED ITEM TOTAL CORRELATIONS


ITEM   R(IT)COR
  1       .554        A POS.
  2       .340        B POS.
  3       .563        B POS.
  4       .196        A POS.
  5       .610        B POS.
  6       .295        B POS.
  7       .289        A POS.
  8       .679        A POS.
```

continued

```
0807201   22  ENGINEERING MANAGEMENT   J. UTTERBACK         01100101
                   ITERATION TO FIRST FACTOR LOADINGS

SUM    2.221  1.483  2.240   .899  2.449  1.287  1.315  2.671

H SG    .307   .115   .317   .038   .372   .087   .083   .462
E      2.527  1.598  2.557   .937  2.821  1.374  1.398  3.132
A(I)    .625   .395   .632   .232   .698   .340   .346   .775

H SG    .391   .156   .400   .054   .487   .115   .120   .600
E      2.611  1.639  2.640   .953  2.936  1.402  1.435  3.271
A(I)    .635   .399   .642   .232   .714   .341   .349   .796

H SG    .404   .159   .413   .054   .510   .116   .122   .634
E      2.624  1.642  2.652   .953  2.959  1.403  1.437  3.304
A(I)    .637   .398   .644   .231   .718   .341   .349   .802

H SG    .406   .159   .414   .053   .516   .116   .122   .643
```

continued

```
0807201   22  ENGINEERING MANAGEMENT   J. UTTERRACK        01100101
PREDICTED CORRELATICN MATRIX

PRED R  SECTION  1


  VAR          ITEM01 ITEM02 ITEM03 ITEM04 ITEM05 ITEM06 ITEM07 ITEM08
ITEM01          0.000   .254   .410   .147   .458   .217   .222   .511
ITEM02           .254  0.000   .257   .092   .286   .136   .139   .320
ITEM03           .410   .257  0.000   .149   .462   .219   .225   .516
ITEM04           .147   .092   .149  0.000   .166   .079   .081   .185
ITEM05           .458   .286   .462   .166  0.000   .245   .251   .576
ITEM06           .217   .136   .219   .079   .245  0.000   .119   .273
ITEM07           .222   .139   .225   .081   .251   .119  0.000   .280
ITEM08           .511   .320   .516   .185   .576   .273   .280  0.000

RESIDUAL MATRIX

RESID   SECTION  1


  VAR          ITEM01 ITEM02 ITEM03 ITEM04 ITEM05 ITEM06 ITEM07 ITEM08
ITEM01          0.000  -.080   .064   .050   .069  -.034  -.104   .037
ITEM02          -.080  0.000  -.011  -.003  -.022   .055   .135  -.074
ITEM03           .064  -.011  0.000  -.044   .054   .005  -.163   .097
ITEM04           .050  -.003  -.044  0.000  -.146  -.009   .135   .016
ITEM05           .069  -.022   .054  -.146  0.000  -.033   .056   .028
ITEM06          -.034   .055   .005  -.009  -.033  0.000   .024  -.008
ITEM07          -.104   .135  -.163   .135   .056   .024  0.000  -.085
ITEM08           .037  -.074   .097   .016   .028  -.008  -.085  0.000

 MEAN RESIDUAL EQUALS    .00031
SIGMA OF RESIDUALS IS    .07370
```

continued

```
NORTHWESTERN UNIVERSITY MAXIMUM LIKLIHOOD PROGRAM    TO EXTRACT ONE FACTOR
  FINAL RESULTS --          NUMBER OF ITERATIONS=    6     RESIDUAL SUM OF SQUARES=  9.364436E-01
COMMUNALITIES
        .449729        .110522        .502127        .037205        .550790        .098629        .069792        .670552
SPECIFIC VARIANCES
        .550271        .889478        .497873        .962795        .449201        .901371        .930208        .329448
FACTOR LOADINGS
        .670619        .332449        .708609        .192887        .742159        .314051        .264182        .818872
          CORRELATION INPUT MATRIX AND RESIDUAL MATRIX
       1.000000        .173546        .474258        .197009        .526413        .182495        .114475        .547861
       -.049401       1.000000        .245679        .089189        .264174        .100447        .274464        .245146
       -.000948        .010103       1.000000        .105181        .515090        .224017        .061760        .612928
        .067655        .025063       -.031501       1.000000        .020214        .069472        .216142        .201634
        .028708        .017444       -.009910       -.122939       1.000000        .211661        .306830        .603632
       -.027614        .086041        .001477        .008895       -.021415       1.000000        .143000        .265117
       -.058690        .186641       -.125442        .165175        .110765        .060034       1.000000        .194507
       -.001290       -.027087        .032667        .043684       -.004101        .017944       -.021924       1.000000
CHI-SQUARE FOR LAWLEY TEST=  31.31993
NO DEG. FREEDOM IS     20
                                        WOLINS  INDEX OF SINGLE FACTOREDNESS
 SIGMA   M                  .3082   SIGMA OF RESIDUALS EQUALS     .0491   EXPECTED  SIGMA              .0311
  INDEX EQUALS      .9348
```

000 0007

COST ESTIMATE

The job listed on the Sample Input consisted of 72 cases and 8 items. Total running time was 2.417 seconds for central-processo time and 24.159 seconds for peripheral-processor time with a memo useage of 45,700 words. Chargeable computer time was $1.03.

Charge to user = computer time + postage and handling + network overhead
= $1.03 + $15.00 + network overhead
= $16.03 + network overhead

CONTENTS—ATTANAL

pages

1,2 Identification & Abstract
3,4 User Instructions
5–10 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Generalized Analysis of Transaction Flows
CALLING NAME	INDIFF NUCC047
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Steven J. Brams, Syracuse University Converted for the CDC 6400 by John E. Michelsen, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201. Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

The model programmed is the Goodman[1,2] generalization of the Savage-Deutsch[3] transaction-flow model, which is applicable to any kind of quantifiable transactions. The Savage-Deutsch model, programmed by Alker[4] was simplified and extended by Goodman to allow for the analysis of matrices in which some diagonal and/or nondiagonal cells contain blank entries. Such entries, which may either be unknown because data are unavailable or unreliable or be known *a priori* to be equal to zero, can be read in with the nonblank entries. The blank entries are excluded, however, from calculations made by the program for the cells with nonblank entries in the data matrix.

The program calculates three sets of indices for all cells that correspond to those having nonblank entries: (1) the deviation

$$D_{ij} = A_{ij} - E_{ij}$$

continued

between the actual volume of transactions from actor i to actor j, A_{ij} and that predicted or "expected," E_{ij} by the model; (2) the relative deviation, or acceptance, of actor i for actor j's transactions, defined as

$$RA_{ij} = D_{ij}/E_{ij},$$

and (3) the difference between the relative acceptance of actor i for actor j's transactions and the relative acceptance of actor j for actor i's transactions, or

$$RADF_{ij} = RA_{ij} - RA_{ji} = (A_{ij}E_{ji} - A_{ji}E_{ij})/E_{ij}E_{ji},$$

which for all i and j for a symmetrical matrix about the main diagonal, except for sign. This last index provides a measure of the imbalance of transaction flows between two actors, after the effects of size have been removed.

To test the hypothesis that the transaction flows are indifferent to all parameters but the total volume of transactions that each actor sends to and receives from all other actors associated with his nonblank entries, the program calculates the goodness-of-fit statistic

$$\chi^2 = \sum_{i=1}^{N} \sum_{j=1}^{N} D_{ij} RA_{ij} = \sum_{i=1}^{N} \sum_{j=1}^{N} (A_{ij} - E_{ij})^2/E_{ij},$$

where N is the order of the matrix. The large-sample distribution of this statistic is the χ^2 distribution with L-2N+1 degrees of freedom, where L is the number of cells with nonblank entries.[5] If χ^2 is sufficiently small that the deviations of the observed values from the predicted values could have occurred by chance, then we would accept the hypothesis that the transaction-flow model "explains" the data. When the χ^2 statistic has more than 30 degrees of freedom,

$$ND = (2\chi^2)^{\frac{1}{2}} - (2L-4N+1)^{\frac{1}{2}}$$

may be used as a normal deviate with unit variance to test the fit of the model to the data.

The percentage of transactions that would have to be moved from one cell into another to make the model fit the data perfectly is also calculated by the program. If

$$T = \sum_{i=1}^{N} \sum_{j=1}^{N} A_{ij} = \sum_{i=1}^{N} \sum_{j=1}^{N} E_{ij},$$

continued

the percentage

$$P = \sum_{i=1}^{N} \sum_{j=1}^{N} \frac{50|D_{ij}|}{T}$$

is, in effect, a measure of the overall magnitude of the discrepancies between the observed and predicted proportions for all cells with nonblank entries.[5]

Finally, several statistics summarizing the distribution of the RA and RADF indices for the cells with nonblank entries are incorporated in the program. Adjunct subroutines to the main program calculate the mean, median, standard deviation, and Pearsonian coefficient of skewness of the RA and RADF indices. In addition, those pairs of actors whose D, RA, or RADF indices are greater than a predetermined amount can be specified in the output.

REFERENCES

1. Goodman, L. A., "Statistical Methods for the Preliminary Analysis of Transaction Flows," Econometrica *31*, 197–208 (Jan. – Apr. 1963).
2. Goodman, L. A., "A Short Computer Program for the Analysis of Transaction Flows," Behavioral Sci. *9*, 176–186 (Apr. 1964).
3. Savage, I. R., and Deutsch, K. W., "A Statistical Model of the Gross Analysis of Transaction Flows," Econometrica *28*, 551–572 (July 1960).
4. Alker, H. R., Jr., "An IBM Program for the Gross Analysis of Transaction Flows," Behavioral Sci. *7*, 498–499 (Oct. 1962).
5. Goodman, L. A., "On the Statistical Analysis of Mobility Tables," Amer. J. Sociol. *70*, 564–585 (Mar. 1965).

USER INSTRUCTIONS

Description of Input Data

Three control cards follow the system cards and precede the data deck. The first two cards define the input variables and the third defines the format of the data matrix.

1. N = the order of the matrix, up to 120
NTYPE = 1 will give printed output for the D, RA, and RADF indices
= 2 will give printed and punched output for these indices
NHIDEC = 1 will give printed output for the pairs of actors whose RA and RADF indices are "significant" (see below)
= 2 will give both printed and punched output for these pairs
INTERVLS = the number of intervals, up to 50, into which the histograms for the RA and RADF indices will be divided

The format for the above variables is 4I3, beginning in card column 1; e.g., 100001002025.

2. RACUT = the level which the RA indices must be equal to or greater than in order that the pairs of actors to which these "significant" indices refer be specified in the output
DCUT = the "significance" level for the RAD indices
RADFCUT = the "significance" level for the RADF indices

Note that the RACUT and DCUT levels are used as simultaneous criteria to produce one set of "significant" pairs. The RADF level is used as an independent criterion to produce another set of "significant" pairs, and it is compared only with the absolute values of the RADF indices.

The format for the above variables is F5.3, F5.1, F5.3, beginning in card column 1; e.g., 0.500100.01.000.

3. The format (enclosed within parentheses) of the data matrix for each row card, of which there may be one or more for each row; e.g., (10F7.2,10X). Note that the terminating card for each row in the data matrix does not have to contain the full complement of entries provided for in the row card format; it simply has to exhaust the row entries.

continued

Job Deck Structure

Job card: use CM7400
LIBRARY(INDIFF)
LGO.
$^{7}8_{9}$ EOR

Program control cards and data deck.

$^{6}{}^{7}8_{9}$ EOI

Description of Output

The program demands that the E's be unchanging in the third decimal place in successive interactions before computing and printing/punching the D and RA indices. The minimum number of iterations necessary to achieve this level of accuracy for all the nonblank cells, (M+1)/2, is indicated by the value of M, always an odd number, given in the printed output. This level of accuracy can easily be changed to fit the precision of the data being analyzed. If M, however, turns out to be greater than 20 (i.e., if the number of iterations necessary to achieve a given level of accuracy exceed 10), the program will have to be modified.

For all cells with nonblank entries in the data matrix, the program computes and prints/punches the D and RA indices one row at a time. In addition, those pairs of actors with nonblank entries whose indices are equal to or greater than predetermined amounts (if the number of such pairs for each actor is not greater than 60) are indicated in the output. More specifically, the numbers following "W" in the output for each row indicate the columnn entries that are equal to or greater than the predetermined levels of significance for the D and RA indices of that row.

The D indices are enclosed within parentheses to distinguish them from the RA indices. For the cells with blank entires, the D and RA indices are set equal to the arbitrary values of 999.0 and 999.0, respectively.

After computing the D and RA indices, the program computes and writes the RADF indices on a binary tape, to which it refers later. It then proceeds to calculate and print for the RA indices with nonarbitrary values (i.e., not equal to 999.0) all the statistics described earlier, as well as producing a histogram of the distribution of the RA indices.

continued

The program then reads back the binary tape and prints/punches the RADF indices, specifying those whose absolute values are equal to or greater than the predetermined amount. It then calculates and prints the mean, median, standard deviation, Pearsonian coefficient of skewness, and a histogram of the nonblank RADF indices in a symmetric half of the matrix. In the calculation of the RADF indices where one or both of the RA indices is equal to 999.0, the following conventions apply.

(1) If $RA_{ij} = 999.0$ and $RA_{ji} = 999.0$, $RADF_{ij} = 0$.

(2) If only $RA_{ij} = 999.0$, $RADF_{ij} = -RA_{ji}$.

(3) If only $RA_{ji} = 999.0$, $RADF_{ij} = RA_{ij}$.

Only in case (1) are the RADF indices considered blank and excluded from the calculation of the above statistics.

To compute the median for the RA and RADF indices, the program first ranks all values of each set of indices and then selects the index of middle rank if the number of nonblank indices is odd. If the number is even, it computes the mean of the two middle-rank indices. Because of ties in ranks, the program occasionally may not find middle-rank indices in either the odd or even cases. If this happens, the median will be set equal to the arbitrary value of 999.0. Since the Pearsonian coefficient of skewness is a function of the median, its value in this case will also be set equal to the arbitrary value of 999.0. Inspection of the histogram, however, will reveal the general nature of the distribution of the indices, even if exact values of the above statistics are lacking.

The user can specify in the input the number of intervals, up to 50, into which he would like the histogram for the RA and RADF indices to be divided. The program calculates and prints the frequency and relative frequency of cases falling in each interval, along with a graph depicting the number of cases, up to 500, in each interval.

Error Indications

This program detects no errors.

Limitations

The transaction matrix may be of order up to and including 120. The RA/RADF index histograms may be divided into one to 50 intervals.

SAMPLE INPUT

```
[redacted]
VLORR.CH[redacted].CM72300.   INDIFF
LIBRARY(INDIFF)
LGO.
' END OF RECORD
 24  1  1 35
 0.25  1.0  1.0
(16F5.0/8F5.0)
       440  101   71  163   76   55  137   36  439  129    7    2    3         1
  124   18    5   16   29  220    3   16                   NAIROBI        1961
  433         3    2    2    2    1    2    1    8  105              2         1
   42    4        74   14   45    1    5                   MOMBASA        1961
  131              1    4    1    1         3   97
                                       1                   NAIVASHA       1961
  122    1                  77                  35
                        1                                  NANYUKI        1961
  180    1    4   70         1    3
                                                           NYERI          1961
   99                             5   16   51   45
    1                   3    9    2    6                   ELDORET        1961
   58    3    1              7        87    1   65
                             4    1                        KERICHO        1961
  204   17    1    1    3   27   55         9   55    1
    1    4             13   21    1   21                   KISUMU         1961
   56    6              1   71        17        16
                        1    3         3                   KITALE         1961
  534   16   46   16    7   47   46   37   15         1
                        1    5         3                   NAKURU         1961
  143   99                                        2       37   33   71   16  108
   31   43   51  111    1   11    4                        DAR ES SALAAM  1961
    3                                             1   39         5    1        15
   13        13    1                                       DODOMA         1961
                                                     36    2             15    5
    2                                                      IRINGA         1961
    1    8                                           64                        3
    2                                                      LINDI          1961
    1                             1                  29        12    1         1
         2         1                                       MBEYA          1961
    8                                               124    8    5         3
    7    1        17                                       MOROGORO       1961
  188   50                        1    1         1   67   18    2              5
         3    1   72    1    2                             MOSHI          1961
   26    6                             8         1   74    3                   2
    3        53        12   18    9                        MWANZA         1961
    6                                                67   18
    3   59                   1    3                        TABORA         1961
   39   92    1                                     120    1    2    1         8
   65    2                             1                   TANGA          1961
   47   10         2         3         6    2    4    3
         4                 155    4   97                   JINJA          1961
  232   51                   5    3   19    1    5   13
    3    6    2       147       228  141                   KAMPALA        1961
    7    2                                            3    1
    1    9         1   17  283         2                   MASAKA         1961
   46   17                  29        24   14    4    1
    2              1  138  294    7                        MBALE          1961
```

```
'END OF INFORMATION
```

000 0008

8000 000

SAMPLE OUTPUT

```
RELATIVE (PA) AND ABSOLUTE (D) ACCEPTANCE INDICES

    ITERATION ACCURATE TO 0.001 AT M = 13


I =  1     999.0000 ( 9999.0)    1.3783 (  255.0)     .6389 (   39.4)     .1075 (    6.9)     .5346 (   56.8)    -.0031 (    -.2)
            -.0297 (   -1.5)     .2923 (   31.0)    -.1014 (   -4.1)    1.2609 (  244.8)    -.3870 (  -81.4)    -.8119 (  -30.2)
            -.9311 (  -27.0)    -.9216 (  -35.3)  999.0000 ( 9999.0)    -.9826 (  -56.6)     .6090 (   46.9)    -.5947 (  -26.4)
            -.9105 (  -50.9)    -.8383 (  -93.3)    -.6920 (  -65.2)    -.2218 (  -62.7)    -.9618 (  -75.5)    -.8149 (  -70.4)

    R+  1W+  2+  3+  5+  8+ 10+ 17+

    P =  32.6


I =  2       1.3828 (  251.3)  999.0000 ( 9999.0)    -.8466 (  -16.6)    -.9017 (  -18.3)    -.9407 (  -31.7)    -.9174 (  -22.2)
            -.9389 (  -15.4)    -.9406 (  -31.6)    -.9214 (  -11.7)    -.8702 (  -53.6)     .5720 (   38.2)  999.0000 ( 9999.0)
          999.0000 ( 9999.0)    -.8354 (  -10.1)  999.0000 ( 9999.0)    -.9453 (  -17.3)     .7169 (   17.5)    -.7162 (  -10.1)
          999.0000 ( 9999.0)    1.0942 (   38.7)    -.5316 (  -15.9)    -.4985 (  -44.7)    -.9599 (  -23.9)    -.8178 (  -22.4)

    R+  2W+  1+ 11+ 17+ 20+

    P =  46.3

                   .
                   .
                   .

I =  23      -.9362 ( -102.7)    -.9436 (  -33.5)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)
          999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)    -.9256 (  -37.3)    -.8597 (   -6.1)
          999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)    -.9323 (  -13.8)     .0576 (     .5)
          999.0000 ( 9999.0)    -.9531 (  -20.3)    -.0579 (   -1.0)    4.2239 (  228.8)  999.0000 ( 9999.0)    -.8793 (  -14.6)

    R+ 23W+ 22+

    P =  70.3


I =  24      -.7176 ( -116.9)    -.6770 (  -35.6)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)     .3371 (    7.3)
          999.0000 ( 9999.0)    -.2042 (   -6.2)     .2284 (    2.6)    -.9276 (  -51.2)    -.9833 (  -58.9)  999.0000 ( 9999.0)
          999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)  999.0000 ( 9999.0)    -.9088 (  -19.9)  999.0000 ( 9999.0)
          999.0000 ( 9999.0)    -.9684 (  -30.7)    4.1511 (  111.2)    2.6554 (  213.6)    -.6866 (  -15.3)  999.0000 ( 9999.0)

    R+ 24W+  6+ 21+ 22+

    P =  58.0
```

continued

```
NUMBER OF NON-BLANK ENTRIES IN RA MATRIX =   259

CHI SQUARE =    14342.122 WITH  212 DEGREES OF FREEDOM

FOR DEGREES OF FREEDOM GREATER THAN 30, NORMAL DEVIATE WITH UNIT VARIANCE = 148.797

OVER-ALL PERCENTAGE OF DISCREPANCIES =  43.8

MEAN OF RA INDICES FOR NON-BLANK ENTRIES IN MATRIX =    .1244

MEDIAN OF RA INDICES FOR NON-BLANK ENTRIES IN MATRIX =   -.6134

STANDARD DEVIATION OF RA INDICES FOR NON-BLANK ENTRIES IN MATRIX =   1.7258

PEARSONIAN COEFFICIENT OF SKEWNESS OF RA INDICES FOR NON-BLANK ENTRIES IN MATRIX =   1.2825
```

continued

```
HISTOGRAM OF  RA INDICES FOR NON-BLANK ENTRIES IN MATRIX

     INTERVALS           FREQ   RFREQ     GRAPH
 -.9881  TO   -.6734,   121.0    .467     111111111111111111111111111111111111111111111111111111111111111111111111111111111111111111
                                          1111111111111111111111111111111
 -.6734  TO   -.3588     33.0    .127     111111111111111111111111111111111
 -.3588  TO   -.0441     17.0    .066     11111111111111111
 -.0441  TO    .2706     20.0    .077     11111111111111111111
  .2706  TO    .5852     12.0    .046     111111111111
  .5852  TO    .8999      7.0    .027     1111111
  .8999  TO   1.2146      3.0    .012     111
 1.2146  TO   1.5292     14.0    .054     11111111111111
 1.5292  TO   1.8439      3.0    .012     111
 1.8439  TO   2.1586      2.0    .008     11
 2.1586  TO   2.4732      5.0    .019     11111
 2.4732  TO   2.7879      4.0    .015     1111
 2.7879  TO   3.1026      3.0    .012     111
 3.1026  TO   3.4172      2.0    .008     11
 3.4172  TO   3.7319      2.0    .008     11
 3.7319  TO   4.0465      0.0   0 000     0
 4.0465  TO   4.3612      2.0    .008     11
 4.3612  TO   4.6759      1.0    .004     1
 4.6759  TO   4.9905      1.0    .004     1
 4.9905  TO   5.3052      0.0   0 000     0
 5.3052  TO   5.6199      2.0    .008     11
 5.6199  TO   5.9345      0.0   0 000     0
 5.9345  TO   6.2492      0.0   0 000     0
 6.2492  TO   6.5639      0.0   0 000     0
 6.5639  TO   6.8785      0.0   0 000     0
 6.8785  TO   7.1932      0.0   0 000     0
 7.1932  TO   7.5079      1.0    .004     1
 7.5079  TO   7.8225      1.0    .004     1
 7.8225  TO   8.1372      1.0    .004     1
 8.1372  TO   8.4519      0.0   0 000     0
 8.4519  TO   8.7665      1.0    .004     1
 8.7665  TO   9.0812      0.0   0 000     0
 9.0812  TO   9.3959      0.0   0 000     0
 9.3959  TO   9.7105      0.0   0 000     0
 9.7105  TO  10.0252      1.0    .004     1
```

000 0008

```
RA DIFFERENCES

I =  1       0.0000    -.0045     .4984     .0672     .3073    -.1583     .2577    -.5347    -.0590    -.0734    -.0129     .1106
             -.9311     .0537     .9594    -.0740    -.0106    -.0068     .0025    -.1255    -.1648    -.1083    -.0256    -.0973

     R. 1W.

I =  2        .0045    0.0000    -.8466     .0719     .0382    -.9174    -.0529    -.4117    -.2389    -.0866     .2311    0.0000
             0.0000    -.4466    0.0000    -.9453     .3840    -.0106    0.0000    -.0021     .1571    -.1015    -.0163    -.1408

     R. 2W.

                  .
                  .
                  .

I =  22       .1083     .1015    0.0000    0.0000    0.0000    -.0692     .0278     .0112    -.0493     .0121     .0376    0.0000
             0.0000    0.0000    0.0000    0.0000     .0503    -.2823     .0489    0.0000     .2574    0.0000    1.1276    -.0875

     R. 22W. 23.

I =  23       .0256     .0163    0.0000    0.0000    0.0000     .8299     .9104     .9347    0.0000    0.0000    -.0533    -.8597
             0.0000    0.0000    0.0000    0.0000    -.9323     .0174     .6830    -.9531     .6487   -1.1276    0.0000    -.1926

     R. 23W. 22.

I =  24       .0973     .1408     .9423    0.0000    0.0000     .8734    0.0000    -.4498     .8886    -.0144    -.9833    0.0000
             0.0000    0.0000    0.0000    0.0000    -.9088    0.0000    0.0000    -.0172   -1.3105     .0875     .1926    0.0000

     R. 24W. 21.
```

continued

000 0008

```
NUMBER OF NON-BLANK ENTRIES IN SYMMETRICAL HALF OF RA DIFFERENCE MATRIX =   152


MEAN OF RA DIFFERENCES FOR NON-BLANK ENTRIES IN MATRIX =   .0578


MEDIAN OF RA DIFFERENCES FOR NON-BLANK ENTRIES IN MATRIX =    .0169


STANDARD DEVIATION OF RA DIFFERENCES FOR NON-BLANK ENTRIES IN MATRIX =    .9034


PEARSONIAN COEFFICIENT OF SKEWNESS OF RA DIFFERENCES FOR NON-BLANK ENTRIES IN MATRIX =    .1360


HISTOGRAM OF  RA DIFFERENCES FOR NON-BLANK ENTRIES IN MATRIX
          INTERVALS           FREQ    RFREQ    GRAPH
 -2.4471  TO  -2.1653          1.0     .007    1
 -2.1653  TO  -1.8835          1.0     .007    1
 -1.8835  TO  -1.6017          1.0     .007    1
 -1.6017  TO  -1.3198          0.0    0 000    0
 -1.3198  TO  -1.0380          2.0     .013    11
 -1.0380  TO   -.7562         19.0     .125    1111111111111111111
  -.7562  TO   -.4744          6.0     .039    111111
  -.4744  TO   -.1926         13.0     .086    1111111111111
  -.1926  TO    .0892         49.0     .322    1111111111111111111111111111111111111111111111111
   .0892  TO    .3710         22.0     .145    1111111111111111111111
   .3710  TO    .6528         12.0     .079    111111111111
   .6528  TO    .9346         16.0     .105    1111111111111111
   .9346  TO   1.2164          7.0     .046    1111111
  1.2164  TO   1.4982          0.0    0 000    0
  1.4982  TO   1.7800          0.0    0 000    0
  1.7800  TO   2.0618          0.0    0 000    0
  2.0618  TO   2.3437          0.0    0 000    0
  2.3437  TO   2.6255          2.0     .013    11
  2.6255  TO   2.9073          0.0    0 000    0
  2.9073  TO   3.1891          0.0    0 000    0
  3.1891  TO   3.4709          0.0    0 000    0
  3.4709  TO   3.7527          0.0    0 000    0
  3.7527  TO   4.0345          0.0    0 000    0
  4.0345  TO   4.3163          0.0    0 000    0
  4.3163  TO   4.5981          0.0    0 000    0
  4.5981  TO   4.8799          0.0    0 000    0
  4.8799  TO   5.1617          0.0    0 000    0
  5.1617  TO   5.4435          0.0    0 000    0
  5.4435  TO   5.7253          0.0    0 000    0
  5.7253  TO   6.0071          0.0    0 000    0
  6.0071  TO   6.2890          0.0    0 000    0
  6.2890  TO   6.5708          0.0    0 000    0
  6.5708  TO   6.8526          0.0    0 000    0
  6.8526  TO   7.1344          0.0    0 000    0
  7.1344  TO   7.4162          1.0     .007    1
```

continued

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 6.360 seconds for central-processor time and 22.054 seconds for peripheral-processor time with a memory useage of 72,300 words. Chargeable computer time was $1.53.

Charge to user = computer time + postage and handling + network overhead
= $1.53 + $15.00 + network overhead
= $16.53 + network overhead

CONTENTS—INDIFF

pages

1–3 Identification & Abstract
5–7 User Instructions
9–14 I/O
15 Cost—Contents

DESCRIPTIVE TITLE	FORTRAN Program for Guttman and Other Scalogram Analyses
CALLING NAME	GUTTSCL NUCC115
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Roland Werner, Department of Sociology, Syracuse University Donald G. Morrison, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

GUTTSCL is designed to perform Guttman and other useful analyses on data supplied in scalogram form. Originally limited to 10 items with up to 7 response categories per item and 200 respondents, the capacity has recently been expanded to 30 items and 350 persons, the Chilton and Raju indices have been added, and other minor modifications have been made. Each data set constitutes an analysis. An unlimited number of such analyses can be treated serially.

Using the Cornell technique for scalogram analysis,[1] a scalogram is displayed in the output with the frequency of the response type, the Guttman and psychometric scores of the response type, and the number of errors in the response type. The item marginal frequencies and the item marginal probabilities are also provided. This information is utilized to calculate the Guttman coefficient of reproducibility. Other coefficients of reproducibility are based upon Loevinger's,[2] Sagi's,[3] and Green's[4] methods of counting errors in a response pattern. The expected coefficients of reproducibility

continued

for each of the error-counting methods are also calculated and are based on Goodman's[5] statistical techniques.

Since a wide range of flexibility in analyzing attitude data is desirable, additional indexes are calculated. These indexes are the Loevinger homogeneity index,[2] the Kuder–Richardson formula, the corrected Kuder–Richardson formula for test reliability,[6] the Green index of consistency,[4] the Borgatta error ratio,[7] the Menzel coefficient of scalability,[8] and the Schuessler χ^2 tests[9] for the frequency distribution of response types. The source of these indexes and their method of calculation is fully described in the references cited below.

REFERENCES

1. Guttman, L., "The Cornell Technique for Scale and Intensity Analysis," Educ. Psychol. Meas. *7*, 247-280 (1947).

2. Loevinger, J., "The Technique of Homogeneous Test Compared with Some Aspects of 'Scalogram Analysis' and Factor Analysis," Psychol. Bull. *45*, 507-529 (1948).

3. Sagi, P.C., "A Statistical Test for the Significance of a Coefficient of Reproducibility," Psychometrika *24*, 19-27 (1959).

4. Green, B.F., "A Method of Scalogram Analysis Using Summary Statistics," Psychometrika *21*, 79-88 (1956).

5. Goodman, L.A., "Simple Statistical Methods for Scalogram Analysis," Psychometrika *24*, 29-43 (1959).

6. Horst, P., "Correcting the Kuder–Richardson Reliability for Dispersion of Item Difficulty," Psychol. Bull. *50*, 371-374 (1953).

7. Borgatta, E.F., "An Error Ratio for Scalogram Analysis," Public Opinion Quart. *7*, 96-100 (1955).

8. Menzel, H., "A New Coefficient for Scalogram Analysis," Public Opinion Quart. *17*, 269-280 (1953).

9. Schuessler, K.F., "A Note on Statistical Significance of Scalograms," Sociometry *24*, 312-318 (1961).

continued

Guttman, L., "The Basis for Scalogram Analysis," in *Measurement and Prediction*, S.A. Stauffer, L. Guttman, and E.A. Suchman, *et al.* Eds. (Princeton University Press, Princeton, N.J., 1950), pp. 60-90.

Werner, R., "A FORTRAN Program for Guttman and Other Scalogram Analyses," Syracuse Univ. (CPA 257). This manual provides the program listing and the instructions for the program's use. The control of the program is achieved with control cards that allow two modes of operation: one mode provides the user with summary frequencies of the attitude data; the other, in addition, calculates various indexes appropriate to attitude data.

USER INSTRUCTIONS

Organization of Input

Two modes of operation are available to the user of this program. The first mode tabulates the item-category marginals only and is identified as 2MARG. This is useful for the initial run, since on the basis of these marginals the cutoff point (for dichotomizing items) can be determined so as to obtain an equitable distribution of marginal frequencies in the final Guttman scale (Ref. 1, p. 258; Ref. 2, p. 119). The second mode of operation includes the first as a convenience and then proceeds in scaling the items. The procedure is most closely approximated by Guttman's Cornell Technique as it applies to dichotomous items.[1] In the program, this mode is identified as 1GUTM.

Figure 1 may aid the user in understanding the instructions that follow. Each set of data is headed by one or the other of these mode-identification cards. The format specifies that 1GUTM or 2MARG be placed in Cols. 1–5 inclusive. Any other information in Cols. 6–70 inclusive will be typed out at the top of the output page and may be used to identify a user's name, project, and the date. Columns 71–75 and 76–80 inclusive must specify the maximum number of respondents and the maximum number of items that the program can handle, respectively. This information must appear right-justified in each field and for this program is always 350 and 30, respectively.

A card indicating the mode of operation must next be followed by a 3MISP card, which serves two functions. It serves to indicate the items that the user wishes in a scalogram and the maximum allowable value that this item may attain. The former is achieved by locating a punch in the desired column, the latter by the value of that punch in the selected column. Columns 1–5 inclusive contain the identification 3MISP.

Another feature of the program that the user may find useful is that items may be reversed at object time. That is, if items from a questionnaire were coded as they appear, it may be the case that the direction of the response of some items is inverted. The 4ITDI card allows the user to invert these items to be consistent with the fact that 1 is always interpreted as an extremely negative response and 7 as an extremely positive response. In other words, the intensity of a response always increases with an increased value of an item. For this operation to take place (when one wishes to invert an item), the number 2 must be placed in the

continued

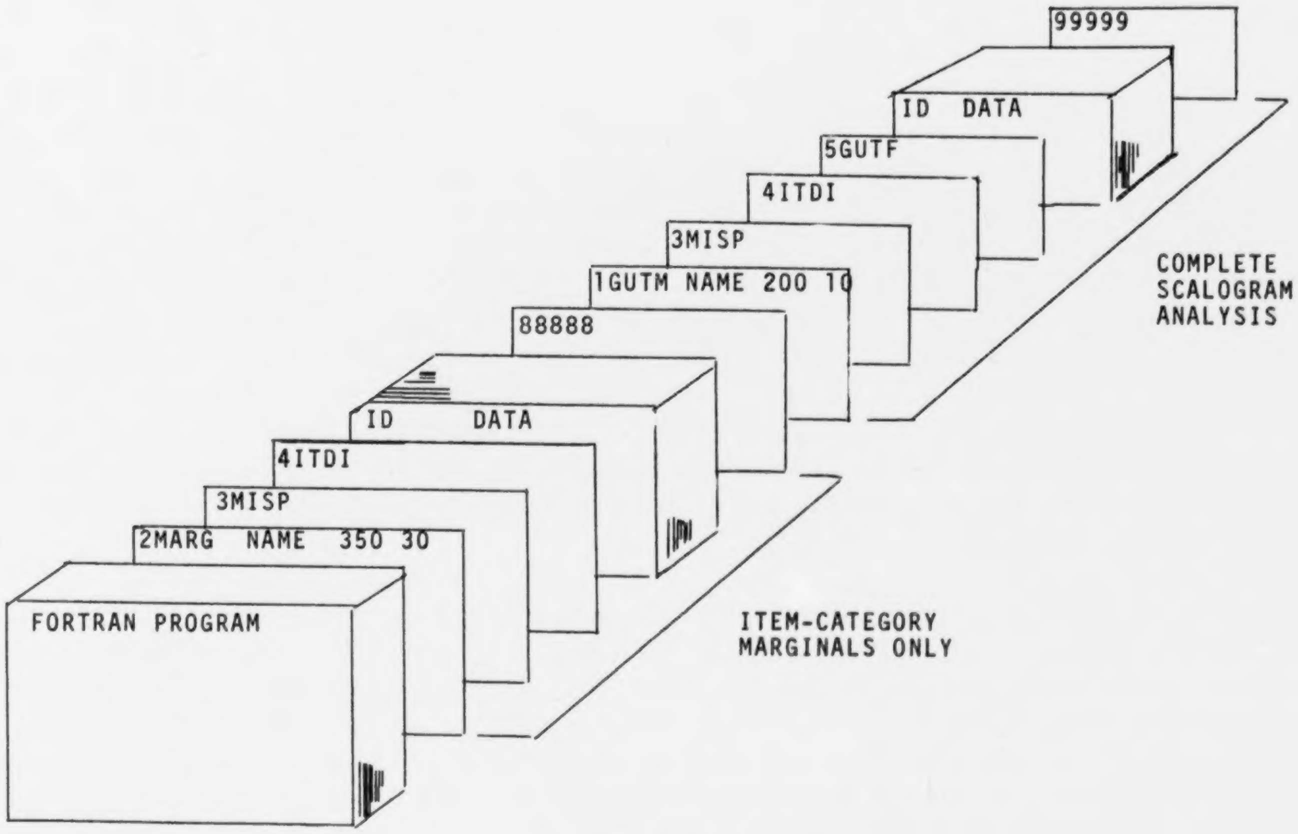

99999
ID DATA
5GUTF
4ITDI
3MISP
1GUTM NAME 200 10
88888
COMPLETE SCALOGRAM ANALYSIS
ID DATA
4ITDI
3MISP
2MARG NAME 350 30
FORTRAN PROGRAM
ITEM-CATEGORY MARGINALS ONLY

Figure 1

column on the 4ITDI card matching the item to be inverted. Otherwise, the number 1 must be placed in all columns that the scalogram analysis is to consider.

If the 2MARG card has been used (only a marginal run is requested), then the data follow next. On the other hand, if the 1GUTM card has been used (the whole Guttman scalogram analysis is requested), then another control card, the 5GUTF card, must specify how to dichotomize each item for this study.

The convention shown in Fig. 2 is followed to specify the cutting point for dichotomizing items.

INTENSITY

LOW ← → HIGH

ITEM CODES	1	.	2	.	3	.	4	.	5	.	6	.	7
CUTTING-POINT CODES		1		2		3		4		5		6	

Figure 2

continued

85

The cutting-point code selected for a column on the 5GUTF card will treat the corresponding item on the data cards by dichotomizing the item in such a way that item codes less than or equal to that code are pooled as negative responses to the item and represented by the digit 0 in the scalogram. Item codes greater than the cutting-point code are pooled as positive responses to the item and are represented by the digit 1. Items that are coded in reversed directions are first transformed and then dichotomized. Therefore, the user must specify the cutting point for these items as it would appear to the transformed values of an item. See Fig. 2. The data now follow this card and processing continues to the next study.

A data card consists of two fields, as indicated above. Columns 1–5 inclusive are used only for control purposes and so may be utilized to contain the identification number of the data card. The user may find this convenient. The program ignores this field. The larger field, Cols. 6–80, is treated as 75 single-column items by the program. A maximum of any combination of 30 items may be selected for analysis, using the 3MISP control card. Each item may have a maximum of seven categories, coded 1 through 7. Either of these extremes may represent an extremely positive or an extremely negative response. The eventual order for the scalogram is determined by the 4ITDI control card.

In a batch operation—e.g., in classroom instruction of attitude scaling—each data set is followed by an 88888 card, coded in Cols. 1–5 inclusive. This card controls processing so that the program continues analysis on the next set of data. The last set of data is followed by a 99999 card, coded in Cols. 1–5 inclusive. This will terminate operation of the program.

Summary of Input

Title Card

Identifies the data and specifies mode of operation.

Columns	
1– 5	1GUTM identifies a complete Guttman scalogram analysis with other associated indexes or, 2MARG identifies item-category marginals-only mode
6–70	Any information that the user wishes printed at the top of the output page
71–75	Maximum number of respondents, right-justified (350)
76–80	Maximum number of items, right-justified (30)

continued

Mispunch Card

Designates columns that will carry data and indicates the maximum allowable punch in any item used in the analysis. Follows either the 1GUTM or 2MARG card.

Columns	
1– 5	3MISP identifies the card
6–80	Maximum allowable punch is entered in all columns corresponding to items that are included in the analysis. Program checks range 1 through the maximum as indicated. Data with a zero punch in any column specified is not included in the scalogram. Maximum allowable punch is a 7 punch in any column

Item-Direction Order Card

Recognizes the items that need to be reversed in order that they are consistent with the scalogram.

Columns	
1– 5	4ITDI identifies the card
6–80	Format in these columns corresponds to format of 3MISP card. Code 1 to leave the item as it is; Code 2 to reverse the item

Dichotomization Card

Indicates, by specifying the cutoff point of an item, which responses in the item are to be considered negative responses and which positive.

Columns	
1– 5	5GUTF identifies the card
6–80	The highest punch of an item indicates the most favorable response toward that item. A cutoff point from 1–6 may be chosen. The cutoff places all responses less than and including it in the negative category and all remaining responses in the positive category of the dichotomy. The categories are coded 0 and 1, respectively, in the scalogram

Data Card

Columns	
1– 5	Identifying number. May not be a number greater than 88887

continued

6–80	The data with maximum allowable punch of 7 in any column of this field. The columns are treated as 75 single-column items, of which a maximum of 30 may be included in the analysis. 350 is the maximum number of respondents (cards) allowed

End Cards

One or the other must follow the data.

Columns

1– 5	88888 indicates to the program that additional studies follow. Analysis continues to the next study
	99999 indicates to the program that the last study has been reached, after which the program stops

Organization of Output

Marginals

The selection of one of the two modes of analysis—i.e., the marginal run or the full Guttman scalogram analysis—will give rise to two different types of output. The marginal run tabulates the frequency of responses 1 through 7 for each item selected for analysis as indicated on the 3MISP card.

The first line of output is the content of the 2MARG card, where any message may appear. The tabulation of information is confined to a fixed five-item format. That is, any multiple of five items, or any number of items less than this multiple but greater than the previous multiple of five items, will generate a new line of tabulations. These lines include the tabulation for each item by response category. From this information, the user can determine the cutting point of an item for further analysis.

Scalogram

By selecting the second mode of analysis, using a 1GUTM card, a tabulation similar to the marginal run results. In addition, there results a Guttman scalogram, a matrix of indices using various error-counting techniques, a table of various other indices, and computational fragments.

The Guttman scalogram is displayed in a somewhat different manner than suggested by Guttman and Stauffer. In this disply of the scalogram, every response occurring in the data is displayed; but, instead of repeating the response pattern as many times as it occurs, it is presented once and is followed by its frequency of occurrence. One loses specificity in identifying each respondent by using this

continued

technique, but the rank ordering of respondents, the essential information, is not only preserved but also condensed.

For each item in the scalogram, the marginal frequency of the positive responses and the marginal probabilities for that item are tabulated. Each marginal frequency is divided by the total number of respondents to generate these probabilities.

Parallel to the scalogram, four vectors appear, representing the frequency of occurrence in the data of each response pattern, the ideal response pattern that any particular pattern most closely approximates (the Guttman score), the number of positive responses in a particular response pattern (the psychometric score—not necessarily equal to the Guttman score, except in the case of the ideal response pattern), and the product of the number of errors of a response pattern and the frequency of occurrence of this pattern.

Finally, associated with the scalogram, is a matrix tabulating various response-pattern probabilities. Beside each number of the ideal response pattern are three probabilities: the ideal expectation (the probability that all responses followed the ideal pattern), the obtained expectation (the empirical probability of each response type—calculated on the basis of the frequencies of the occurrence of ideal types in the scalogram), and the chance expectation (the chance-expected probability of an ideal response type, based upon the product of the positive- and negative-response marginal probabilities for each ideal response type).

Other Error-Counting Methods

Various error-counting procedures for nonscale-type responses in a scalogram have been developed by Guttman,[1] Loevinger,[3] Sagi,[4] and Green.[5] This Table in the output is based on the procedures, each row being labeled with the person to whom it refers.

Raju and Guttman[6] have provided an alternate index of unidimensionality, listed in the readout at this point. Chilton[7] has provided an extension of Scheussler's analysis, and his expected reproducibility, standard error, and Z value are listed next.

Following this are two groups of computational fragements used in calculating values for the Table just mentioned, along with another group of indexes calculated in the manner intended by the referenced authors. These indexes were included to describe the data further. The student will find it instructive to compare these indexes to those mentioned earlier. Loevinger's homogeneity index leads the list of indexes. The Kuder-Richardson reliability index[8] is followed by the value of the F ratio and the corresponding degrees of freedom for tests of significance.

continued

Then there are two values for the index consistency I as proposed by Green[5] (since he suggests two coefficients of reproducibility), the Borgatta error ratio, which is equal to the "ratio of errors in the scale to the maximum number of errors for a scale of the same marginal frequencies" (Ref. 9, p.99), Menzel's coefficient of scalability (as developed in his article[10]), and Schuessler's χ^2 tests for the goodness of fit between the observed distribution of the response-pattern frequencies and the expected distribution of the response-pattern frequencies.[11]

Error Message

There are various appropriate error messages that are printed whenever faulty input data are supplied. If a zero is coded in any column under consideration, a list of the cards which so qualify (and are therefore not included in the scalogram) is printed. Other forms of mispunching, such as a value greater than the maximum allowable punch (from 3MISP card), will cause termination of the analysis of this data set. Omitting the 3MISP card has the same effect.

If the columns on the 4ITDI card do not match those on the 3MISP card, or if the 4ITDI card is omitted, termination of the current data analysis will also occur. This, of course also applies to the 5GUTF card.

Two other possible errors may occur in the data. If more than 350 respondents are represented in the data set, the analysis of a study is halted. Second, if more than 30 items are indicated on the 3MISP card, only the first 30 items will be processed; therefore operation is not terminated. However, as in all the above instances of error, a suitable message will be printed upon finding that condition.

REFERENCES

1. Guttman, L., "The Cornell Technique for Scale and Intensity Analysis," Educ. & Psychol. Meas. *7*, 247-280 (1947).

2. Stauffer, S.A., *et al.*, *Studies in Social Psychology in World War II*, Vol. 4 of *Measurement and Prediction*, S.A. Stauffer, L. Guttman, E.A. Suchman, *et al.*, Eds. (Princeton University Press, Princeton, N.J., 1950), pp. 3-361.

3. Loevinger, J., "The Technique of Homogeneous Tests Compared with Some Aspects of 'Scale Analysis' and Factor Analysis," Psychol. Bull. *45*, 507-529 (1948).

continued

4. Sagi, P.C., "A Statistical Test for Significance of a Coefficient of Reproducibility," Psychometrika *24*, 19-27 (1959).

5. Green, B.F., "A Method of Scalogram Analysis Using Summary Statistics," Psychometrika *21*, 79-88 (1956).

6. Raju, N.S., and L. Guttman, "A New Criterion for a Perfectly Homongeneous Test with an Index of Homogeneity," Amer. Psychol. *21*, No. 7, 671 (A) (1966); also Sci. Res. Assoc., E. Erie St., Chicago, Res. Rept.

7. Chilton, R.J., "Computer Generated Data and the Statistical Significance of Scalogram," Sociometry *29*, No. 2, 175-181 (1966).

8. Horst, P., "Correcting the Kuder-Richardson Reliability for Disperson of Item Difficulty," Psychol. Bull. *50*, 371-374 (1953).

9. Borgatta, E.F., "An Error Ratio for Scalogram Analysis," Public Opinion Quart. *7*, 96-100 (1955).

10. Menzel, H., "A New Coefficient for Scalogram Analysis," Public Opinion Quart. *17*, 268-280 (1953).

11. Schuessler, K.F., "A Note on Statistical Significance of Scalograms," Sociometry *24*, 312-318 (1961).

Werner, R., "A FORTRAN Program for Guttman and Other Scalogram Analyses," Syracuse Univ. (CPA 257). This manual provides the program listing and the instructions for the program's use. The control of the program is achieved with control cards that allow two modes of operation: one mode provides the user with summary frequencies of the attitude data; the other, in addition, calculates various indexes appropriate to attitude data.

SAMPLE INPUT

```
VLORR,CH[redacted],CM64700.    GUTTSCL
LIBRARY(GUTTSCL)
LGO.
1GUTM   DONALD MORRISON TEST OF GUTTMAN PROGRAM   MAY 4, 1967          350   30
3MISP              44444444
4ITDI              22222222
5GUTF              32122112
                   14411443
                   24234442
                   12422441
                   14424443
                   1412443
                   44414444
                   11111111
                   13224443
                       .
                       .
                       .
                   22222222
                   32434443
                   12421441
                   44424444
                   11412440
                   14423442
                   23222223
                   33434423
                   12412431
                   22222222
                   12424443


88888
1GUTM   SCHUESLER HYPOTHETICAL DATA   3ITMS                            350   30
3MISP                 222
4ITDI                 111
5GUTF                 111
001                   222
002                   222
003                   222
 .                     .
 .                     .
 .                     .
030                   222
031                   221
032                   221
033                   221
 .                     .
 .                     .
 .                     .
055                   221
056                   212
057                   212
058                   212
059                   122
060                   211
061                   211
062                   211
 .                     .
 .                     .
 .                     .
081                   211
082                   121
083                   121
084                   121
085                   121
086                   112
087                   111
088                   111
089                   111
 .                     .
 .                     .
 .                     .
099                   111
100                   111
8888888888
```

continued

000 0009

```
1GNTM         TESTING RAJU INDEX ON HIS DATA                            350   30
3MISP22222222
4ITDI11111111
5OUTF11111111
     22222212
     21221222
     22221112
     22112221
     22212121
     21221121
     22112211
     22121111
     21112111
     21111111
999999999999999
```

SAMPLE OUTPUT

```
DONALD MORRISON TEST OF GUTTMAN PROGRAM   MAY 4, 1967
 FOLLOWING CARDS NOT INCLUDED IN SCALE, ZERO PUNCH IN  A COLUMN
 CARD NO   -0  COL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   20
 CARD NO   -0  COL NO,   26
 CARD NO   -0  CCL NO,   26
 CARD NO   -0  CCL NO,   26


ITEMNO                19                          20                          21                          22                          23
CATEG      1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7

FREQ       7  11  54  95   0   0   0  28  16  90  33   0   0   0 118   3  42   4   0   0   0  15  21  75  56   0   0   0  50  16  81  20   0   0   0

TFREQ                167                         167                         167                         167                         167


ITEMNO                24                          25                          26                           0                           0
CATEG      1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7   1   2   3   4   5   6   7

FREQ     139   2  22   4   0   0   0 118   9  38   2   0   0   0  19  45  58  45   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0   0

TFREQ                167                         167                         167                           0                           0
```

continued

```
                                                                        FRFQU   PSYCH
                                                                                SCORE
                                                                            GUTMN   FRROR
                                                                            SCORE
TFMAO
24 21 25 19 23 26 20 22
 1  1  1  1  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      7   8   8   0
 1  1  1  0  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0     12   8   7  12
 1  1  1  1  1  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   8   7   1
 1  0  1  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   8   6   4
 1  1  1  0  1  0  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   8   5   6
 1  1  1  0  1  1  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   8   5   3
 1  1  0  1  0  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   8   5   3
 1  1  1  0  1  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   8   5   3
 0  1  1  1  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      3   7   7   0
 0  1  1  0  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      4   7   6   4
 0  1  1  1  1  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   7   6   1
 0  1  1  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   7   6   2
 0  1  1  0  0  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   7   5   2
 0  1  1  0  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   7   5   2
 0  0  1  1  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      6   6   6   0
 0  0  1  1  0  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   6   5   1
 0  0  1  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   6   5   1
 0  0  1  0  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   6   4   2
 0  0  0  1  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0     22   5   5   0
 0  1  0  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      4   5   5   8
 1  0  0  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   5   5   2
 0  1  0  1  1  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   5   5   2
 0  1  0  1  0  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   5   5   2
 0  0  0  1  1  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      4   5   4   4
 0  0  0  1  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      6   5   4   6
 0  0  0  1  0  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      A   5   4   A
 0  0  0  1  1  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   5   4   1
 0  0  0  1  1  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   5   3   4
 0  0  0  1  0  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      3   5   3   6
 0  0  0  1  0  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      3   5   3   6
 0  0  0  1  1  0  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   5   3   2
 0  1  0  0  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   4   5   1
 0  0  0  0  1  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      5   4   4   0
 0  0  0  0  1  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   4   3   1
 0  0  0  0  1  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   4   3   1
 0  0  0  0  0  1  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   3   3   0
 0  1  0  0  0  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   3   3   2
 0  0  0  0  0  1  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   3   2   1
 0  0  0  1  0  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      6   2   3   6
 0  0  0  0  1  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      5   2   3   5
 0  0  0  0  0  0  1  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      5   2   2   0
 0  1  0  1  0  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   1   3   2
 0  1  0  0  0  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   1   3   2
 0  0  1  0  0  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   1   3   2
 0  0  0  1  0  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      3   1   2   3
 0  0  0  0  0  1  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   1   2   2
 0  0  0  0  1  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   1   2   1
 0  1  0  0  0  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   1   2   1
 0  0  0  0  0  0  0  1  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      5   1   1   0
 0  1  0  0  0  1  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   0   2   2
 0  0  0  1  0  1  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   0   2   2
 0  0  0  1  0  0  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      2   0   1   2
 0  0  0  0  0  1  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      6   0   1   6
 0  0  0  0  0  0  1  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   0   1   1
 0  0  1  0  0  0  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      1   0   1   1
 0  0  0  0  0  0  0  0  0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0      A   0   0   0
```

continued

```
MARGINALS
28 49 49 95101103123131  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

PROBABILITIES
.17   .29   .60   .74  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00
   .29   .57   .62   .78  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00
                                                                                           TOT ERROR  142
                                                                                           TOT RESPS 1336
                                                                                           TOTAL N    167

     IDEAL  IDEAL  OBTND   CHANCE
     TYPE   EXP            EXP
        0    .168   .048   .00177
        1    .126   .030   .00878
        2   0.000   .030   .02116
        3    .275   .006   .05095
        4    .036   .030   .03861
        5    .012   .132   .02523
        6    .120   .036   .01568
        7    .048   .018   .00561
        8    .216   .042   .00154

TOTALS      1.000   .371   .16932

                    TOTAL      COFR       EXP       EXP      ERROR     ERROR      COFR      COFR
                    ERROR                 ERROR     COFR     SDDEV      ZEE      SDERR      ZEE

GUTTMAN             142.0      .894

LOEVINGER           354.0      .735      569.4      .574    13.973   -15.413      .010    15.413

SAGI                136.0      .898      205.4      .846     7.271    -9.550      .005     9.550

GREEN B             140.3      .895      224.0      .832     7.288   -11.481      .005    11.481

GREEN B BASED ON GOCDMANS EXP ERROR                                                .008     7.468

GREEN A                        .895

                     ***               ***               ***               ***

FRAGMENT1

SAGI METH
   0    1    1    2    3    2    2    2    0    1    1    1    1    2    0    1    1    2    0    2
   2    2    2    1    1    1    1    1    2    2    2    1    0    1    1    0    2    1    1    1
   0    2    2    2    1    1    1    1    0    2    2    1    1    1    1    0
LOEV METH
   0    3    7    5   12   13    8   11    0    2    6    4    4    5    0    2    3    3    0    4
   5    5    3    4    2    1    3    4    4    3    5    2    0    2    3    0    6    2    2    1
   0    7    5    4    3    1    2    5    0    7    5    4    2    1    5    0
```

continued

```
GREEN MRG
N G+2,-G                  0   27    4   32    8   21    0    0
N G+1,-G-1                0    2   27    4   32    8    0    0
N G+2,G+1,-G,-G-1         0    0    1    0    2    1    0    0

PROB OF RESP
 .002  .001  .000  .003  .000  .000  .002  .000  .009  .007  .002  .005  .004  .004  .021  .014  .013  .010  .051  .013
 .006  .008  .014  .014  .032  .033  .018  .011  .009  .012  .009  .016  .039  .014  .011  .025  .003  .007  .021  .024
 .016  .003  .004  .004  .007  .009  .009  .002  .006  .001  .003  .002  .002  .004  .001  .002
FREC OF RESP
  .30   .22   .08   .44   .04   .02   .29   .05  1.47  1.11   .40   .91   .73   .69  3.53  2.31  2.20  1.66  8.51  2.20
 1.06  1.26  2.31  2.34  5.29  5.56  3.04  1.89  1.53  1.99  1.45  2.68  6.45  2.31  1.77  4.21   .48  1.16  3.45  4.01
 2.62   .51   .63   .63  1.24  1.51  1.43   .39   .94   .17   .55   .34   .41   .72   .11   .26

RAJU INDEX OF HOMOGENIETY   .8439
CHILTON EXPECTED GUTTMAN SCORE       .94                STANDARD SCORE    .6734                Z SCORE    6.1643

            ***                 ***                 ***                 ***

LOEVINGER       .378

KUD-RICH        .699    F LEVEL    3.322     DEGREES OF FREEDOM    166   1162 INFERRED INTER ITEM CORRELATION      .225

CORECT K-R      .759    F LEVEL    4.141     DEGREES OF FREEDOM    166   1162 INFERRED INTER ITEM CORRELATION      .282

GREEN I         .375      .374        NOT SCALFABLE

BORG RATIO      .980

MENZEL COFS     .635                  NOT SCALFABLE

SCHUESSLER A    63.938      DF      1

SCHUESSLER B  1022.028      DF     15

MINIMAL MARGINAL REP =     .695  GUTTMAN COEF REP INCREASE OVER MMR =     .199

JACKSON PLUS PERCENTAGE RATIO =     .652

            ***                 ***                 ***                 ***
```

continued

```
FRAGMENT2

LOEVINGER
PSYCH=SCORE RES SUM
   8   15   15   27   25   39   15   16    7

SUM X         679.00
SUM X**2     3465.00
MEAN            4.07
TOT VAR         4.22
MAX VAR         8.46
SUM P*Q       1.6380

BORG MAX ER     8.00

MENZ COFS
SUM ITEM MOD FREQU      928.00
SUM RESP MOD FREQU      947.00
MAX ERR (ITEM)          408.00
MAX ERR (RESP)          389.00

SCHUESSLER 1 INGREDIENTS, IDEAL OBS =   62.00IDEAL EXP =   28.28ERROR OBS =  105.00ERROR EXP =   65.56
SUM SCALE THEO FREQU
  .30  1.47  3.53  8.51  6.45  4.21  2.62   .94   .26   .31  2.87 15.83 17.89 20.65  6.44
SUM SCALE EMP FREQU
   7    3    6   22    5    1    5    5    8   13    9   17   20   26   10

                 ***                 ***                 ***                 ***


   SCHUESLER HYPOTHETICAL DATA   3ITMS


ITEMNO          24                25                26                0                 0
CATEG    1  2  3  4  5  6  7  1  2  3  4  5  6  7  1  2  3  4  5  6  7  1  2  3  4  5  6  7  1  2  3  4  5  6  7

FREQ    20 80  0  0  0  0  0 40 60  0  0  0  0  0 65 35  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

TFREQ          100               100               100                0                 0
```

continued

```
TEMNO
26 25 24
 1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

MARGINALS
35 60 80  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

PROBABILITIES
.35   .80  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00
   .60  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00


    IDEAL  IDEAL   OBTND   CHANCE
    TYPE   EXP             EXP
       0    .350    .140   .16800
       1    .250    .220   .31200
       2    .200    .250   .20800
       3    .200    .300   .05200

TOTALS     1.000    .910   .74000


              TOTAL      COFR      EXP       EXP      ERROR     ERROR     COFR      COFR
              ERROR                ERROR     COFR     SDDEV     ZEE       SDERR     ZEE

GUTTMAN         9.0      .970

LOEVINGER      11.0      .963      33.0      .890     3.597    -6.116     .012     6.116

SAGI            9.0      .970      26.0      .913     3.050    -5.575     .010     5.575

GREEN B         9.0      .970      26.0      .913     3.159    -5.381     .011     5.381

GREEN B BASED ON GOODMANS EXP ERROR                                     .010     5.754

GREEN A                  .970

            ***                  ***                  ***                  ***
```

```
FREQU   PSYCH
         SCORE

    GUTMN   ERROR
    SCORE

30    3    3    0
 3    3    2    3
 1    3    2    1
25    2    2    0
 4    2    1    4
22    1    1    0
 1    0    1    1
14    0    0    0



TOT ERROR    9
TOT RESPS  300
TOTAL N    100
```

continued

```
FRAGMENT1

SAGI METH
   0    1    1    0    1    0    1    0
LOEV METH
   0    1    2    0    1    0    2    0

GREEN MRG
N G+2,-G                  0    0    0
N G+1,-G-1                0    0    0
N G+2,G+1,-G,-G-1         0    0    0

PROB OF RESP
 .168  .112  .042  .312  .078  .208  .028  .052
FREQ OF RESP
16.80 11.20  4.20 31.20  7.80 20.80  2.80  5.20

RAJU INDEX OF HOMOGENIETY   .8825
CHILTON EXPECTED GUTTMAN SCORE       .91                 STANDARD SCORE    1.6244                Z SCORE    3.4886

             ***                 ***                 ***                 ***


LOEVINGER       .667

KUD-RICH        .618     F LEVEL     2.620     DEGREES OF FREEDOM     99    198 INFERRED INTER ITEM CORRELATION      .351

CORECT K-R      .804     F LEVEL     5.104     DEGREES OF FREEDOM     99    198 INFERRED INTER ITEM CORRELATION      .578

GREEN I         .654      .654

BORG RATIO      .346

MENZEL COFS     .839

SCHUESSLER A    15.021      DF      1

SCHUESSLER B    37.962      DF      5

MINIMAL MARGINAL REP =     .683  GUTTMAN COEF REP INCREASE OVER MMR =     .287

JACKSON PLUS PERCENTAGE RATIO =     .905

             ***                 ***                 ***                 ***
```

continued

```
FRAGMENT2

LOEVINGER
PSYCH-SCORE RES SUM
  14   27   29   30

SUM X         175.00
SUM X**2      413.00
MEAN            1.75
TOT VAR         1.07
MAX VAR         1.29
SUM P*Q        .6275

BORG MAX ER   14.00

MENZ COFS
SUM ITEM MOD FREQU     205.00
SUM RESP MOD FREQU     244.00
MAX ERR (ITEM)          95.00
MAX ERR (RESP)          56.00

SCHUESSLER 1 INGREDIENTS, IDEAL OBS =   91.00IDEAL EXP =   74.00ERROR OBS =    9.00ERROR EXP =   26.00
SUM SCALE THEO FREQU
16.80 31.20 20.80  5.20 15.40
SUM SCALE EMP FREQU
  30   25   22   14    4
.   .
.   .
.   .
        TESTING RAJU INDEX ON HIS DATA


ITEMNO           6                    7                    8                    9                    10
CATEG   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7

FREC    0 10  0  0  0  0  0   4  6  0  0  0  0  0   5  5  0  0  0  0  0   5  5  0  0  0  0  0   5  5  0  0  0  0  0

TFREQ           10                   10                   10                   10                   10


ITEMNO  .       11                   12                   13                    0                    0
CATEG   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7   1  2  3  4  5  6  7

FREC    6  4  0  0  0  0  0   6  4  0  0  0  0  0   7  3  0  0  0  0  0   0  0  0  0  0  0  0   0  0  0  0  0  0  0

TFREQ           10                   10                   10                    0                    0
```

continued

100

000 0009

```
TFMNO
13 12 11  8  9 10  7  6
 1  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  1  1  1  1  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  0  1  0  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  0  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  1  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  1  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 1  0  0  1  1  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  1  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  1  0  0  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  1  0  0  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  1  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  1  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  1  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  1  0  1  1  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  1  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
 0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

MARGINALS
 3  4  4  5  5  5  6 10  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0

PROBABILITIES
.30   .40   .50   .60  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00
   .40   .50   .50  1.00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 00  0 0


FREQU   PSYCH
        SCORE
   GUTMN     ERROR
   SCORE

 0    8    8    0
 1    8    6    2
 0    7    7    0
 1    7    5    2
 1    6    7    1
 0    6    6    0
 0    5    5    0
 1    5    5    2
 0    4    4    0
 1    3    5    2
 1    3    4    1
 0    3    3    0
 1    2    3    1
 0    2    2    0
 1    1    4    3
 1    1    2    1
 1    1    1    0
 0    0    0    0


TOT ERROR    15
TOT RESPS    80
TOTAL N      10


   IDEAL  IDEAL   OBTND   CHANCE
   TYPE   EXP             EXP
      0    .300   0.000   .00360
      1    .100    .100   .00840
      2   0.000   0.000   .01260
      3    .100   0.000   .01890
      4   0.000   0.000   .01890
      5   0.000   0.000   .01890
      6    .100   0.000   .01890
      7    .400   0.000   .01260
      8   0.000   0.000  0.00000

TOTALS    1.000    .100   .11280
```

continued

```
                     TOTAL      COFR      EXP       EXP      ERROR     ERROR     COFR      COFR
                     ERROR                ERROR     COFR     SDDEV     ZEE       SDERR     ZEE

GUTTMAN              15.0       .813

LOFVINGER            34.0       .575      40.4      .495     3.477    -1.841     .043      1.841

SAGI                 12.0       .850      13.2      .835     1.879    -.639      .023      .639

GREEN B              13.5       .831      15.0      .813     1.884    -.775      .024      .775

GREEN B BASED ON GOODMANS EXP ERROR                                              .042      .436

GREEN A                         .812

                    ***                 ***                 ***                 ***

FRAGMENT1

SAGI METH
  0   1    0    2    1    0    0    2    0    1    1    0    1    0    2    1    0    0
LOFV METH
  0  10    0    3    1    0    0    5    0    4    2    0    1    0    7    1    0    0

GREEN MRG
N G+2,-G                 0    1    2    3    2    0    0    0
N G+1,-G-1               0    1    1    2    3    2    0    0
N G+2,G+1,-G,-G-1        0    0    1    0    2    0    0    0

PROP OF RESP
 .004  .002  .008  .013  .005  .013  .019  .008  .019  .008  .013  .019  .019  .019  .008  .013  .013 0.000
FREQ OF RESP
  .04   .02   .08   .13   .05   .13   .19   .08   .19   .08   .13   .19   .19   .19   .08   .13   .13  0.00

RAJU INDEX OF HOMOGENIETY    .6400
CHILTON EXPECTED GUTTMAN SCORE      .98                STANDARD SCORE    1.4541                Z SCORE   11.7105

                    ***                 ***                 ***                 ***
```

continued

```
LOEVINGER        .158

KUD-RICH         .494     F LEVEL     1.977     DEGREES OF FREEDOM      9     63 INFERRED INTER ITEM CORRELATION      .109

CORECT K-R       .522     F LEVEL     2.094     DEGREES OF FREEDOM      9     63 INFERRED INTER ITEM CORRELATION      .120

GREEN I         -.003      .098          NOT SCALEABLE

BORG RATIO      1.353EMP ERROR GREATER THAN MAX ERROR

MENZEL COFS      .423                    NOT SCALEABLE

SCHUESSLER A    73.513      DF       1

SCHUESSLER B    73.656      DF      13

MINIMAL MARGINAL REP =     .625  GUTTMAN COEF REP INCREASE OVER MMR =     .188

JACKSON PLUS PERCENTAGE RATIO =     .500

                ***                ***                ***                ***

FRAGMENT2

LOEVINGER
PSYCH-SCORE RES SUM
   0    1    1    1    2    3    1    1    0

SUM X          42.00
SUM X**2      206.00
MEAN            4.20
TOT VAR         2.96
MAX VAR         9.76
SUM P*Q       1.6800

BORG MAX FR     0.00

MENZ COFS
SUM ITEM MOD FREQU        50.00
SUM RESP MOD FREQU        54.00
MAX ERR (ITEM)            30.00
MAX ERR (RESP)            26.00

SCHUESSLER 1 INGREDIENTS, IDEAL OBS =    1.00IDEAL EXP =    1.13ERROR OBS =    9.00ERROR EXP =     .89
SUM SCALE THEO FREQU
  .04   .08   .13   .19   .19   .19   .19   .13  0.00   .29   .05   .21   .19
SUM SCALE EMP FREQU
   0     0     0     0     0     0     0     1     0     3     1     2     1

                ***                ***                ***                ***
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 33.485 seconds for central-processor time and 93.502 seconds for peripheral-processor time with a memory useage of 64,700 words. Chargeable computer time was $7.41.

Charge to user = computer time + postage and handling + network overhead
= $7.41 + $15.00 + network overhead
= $22.41 + network overhead

CONTENTS—GUTTSCL

pages

1–3 Identification & Abstract
5–12 User Instructions
13–25 I/O
27 Cost—Contents

DESCRIPTIVE TITLE	Stepwise Multiple-Discriminant Analysis
CALLING NAME	EIDISC NUCC068
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Donald G. Morrison, Council for Intersocietal Studies, Northwestern University Richard J. Art, Jr., Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

The basic stepwise procedure uses Rao's generalized distance statistic[1] to omit all variables that do not add significantly to the distance between groups. The analysis proceeds with all excluded variables set equal to zero in the discriminant functions. Group- and subject-membership probabilities are calculated. Discriminant scores are also calculated and plotted for the first two functions derived. A histogram is used if only one function is derived.

While several multiple-discriminant computer programs exist, they all are analogous to standard multiple regression in the sense that all the variables are included in the function, irrespective of their ability to increase the discriminating power of the functions derived. It is quite possible to add to the analysis variables that decrease group differences.[2] As a result, discriminant functions derived by the standard multiple-discriminant methods can often be considerably improved in their power to discriminate by the use of the stepwise procedure. There is also the added benefit of working with fewer original variables.

continued

The major question of the stepwise procedure revolves around the choice of the criteria with which to add variables. We have not used the F-ratio method of stepwise regression analysis but followed Rao[1] and used the increase in Rao's V (Ref. 1, p.257) as the entry criterion for the stepwise procedure. (The F ratio will not be able to measure the increased "distance" that a new variable will provide.) Once it is decided which variables shall be included in the analysis, then the procedure follows the methods of multiple-discriminant analysis in the reduced-variable space.

The output of the program is intended to give as much information as possible so that powerful discriminant functions can be derived. This includes measures of the discriminatory power of the derived functions, such as plots of the discriminant scores and classification of the raw input data of the discriminant function(s). Further, unclassified subjects can be classified by the program after the calculation of the discriminant function(s).

Briefly, the stepwise procedure uses the variable with the best univariate F ratio (between-groups variance to within-groups variance) as a starting point. Each of the remaining variables is tested to determine which of them adds the most to the distance statistic, a generalized Mahalanobis' D^2 described by Rao (Ref.1, p.257) and referred to as Rao's V. The greatest additional distance is tested as chi square with groups-minus-one degrees of freedom. If the "best" variable adds a significant amount, the process is repeated, testing the remaining set of variables to determine the best third variable to use in combination with the first two selected. This search-and-test process continues until it is found that none of the remaining variables adds a "significant" amount to the distance.

REFERENCES

1. Rao, C.R., *Advanced Statistical Methods in Biometric Research* (John Wiley & Sons, Inc., New York, 1952), Chaps. 7–9.

2. Morrison, D. G., and Art, R. C., Jr., "A FORTRAN Program for Stepwise Multiple Discriminant Analysis" (Northwestern University, 1967), pp.14–25. Copies may be obtained from Donald Morrison, Council for Intersocietal Studies, Northwestern University, 1818 Sheridan Road, Evanston, Ill. 60201.

USER INSTRUCTIONS

Description of Input Data

Control Cards

Problem Card (*first card* for each analysis)

Columns	*Information*
1–2	The *number of groups* on which the analysis is based
3–4	The *number of variables*
5	=1 if another analysis follows this one =0 if not
6	=1 if an ungrouped set of subjects follows the last group (OPT1) =0 if not
7	=1 if a *plot* of the first two discriminant scores for each group is desired =0 if not
8	*Must* be 0 (zero)
9	=1 if total sample within-groups, between-groups, and total sums-of-squares and crossproducts matrices are to be printed =0 if not
10	=1 if group sums-of-squares and crossproducts, deviation sums-of-squares and crossproducts, and variance-covariance matrices are to be printed =0 if not
11–14	Chi square with number-of-groups-minus-one degrees of freedom to limit variables entering analysis; e.g., 5.99 (punch decimal point for 3 groups at .05 level of significance)
15–17	Percent of total variance to be explained by functions; e.g.,99.(punch decimal point)
18–22	Number of subjects in the unclassified group if column 6=1; otherwise leave blank

The *second card* on through as many cards as required (maximum of 5) should contain the *variable names* at *six columns per name*, 12 names per card, starting in column 1; thus, the 12th name is in columns 66–72 of the first variable–name cards, the 13th name is in columns 1–6 of the second variable–name cards, etc., as needed.

continued

For *each group* the following cards *must* be prepared.

Group Card

Columns	*Information*
1–2	The *number of variables* (must match problem card). Right-adjusted
3–7	The *number of subjects* in this group (right-adjusted)

Group-Title Card

1–72	Alphanumeric group title (need not fill 72 columns)

Variable-Format Cards (3 required)

Standard BMD floating-point-type variable-format cards

NOTE: Subject ID is read as the first variable on the first card in A-type format, although not counted in number of variables. If format does not fill 3 cards, use blank cards to fill out.

Description of Output (not necessarily in order shown)

1. For each group: dispersion, raw and deviation sums-of-squares, and crossproducts matrices (optional—not shown in sample)
2. For each group: means, standard deviations, and correlation matrix.
3. Total sample: within-groups, between-groups, and total sums-of-squares and crossproducts matrices. Labeled W, A, and T matrices, respectively (optional—not all shown in sample)
4. Total sample: means, standard deviations, correlation matrix, and total-sample size
5. Univariated F ratios for each variable (standard one-way analysis of variance F's)
6. Table of the generalized distance statistic (Rao's V) from the stepwise procedure
7. Eigenvalues (roots) of $W^{-1}*A$, trace of roots, and roots as percents of trace
8. Eigenvectors of $W^{-1}*A$ (discriminant functions) associated with above roots

continued

9. Scaled vectors to show the relative contribution of the selected variables to the functions
10. Wilk's lambda and F test for the hypothesis that the group means are the same over the groups in question and the variables selected
11. Centroids of the groups in the discriminant space
12. Dispersion matrix for each group in the discriminant space
13. Chi squares and group-membership probabilities for the group centroids
14. Discriminant scores, chi squares, and group-membership probabilities for each subject—(not shown in sample)
15. Plots of the first two discriminant-function scores for each of the groups (optional—not shown in sample)

It is suggested that the group and total-sample optional matrices not be requested unless necessary as they require time and produce output that is often useless for the average user.

Error Indications

Error messages for negative or zero gamma-function arguments, bad inputs to the plot routine.

Limitations

The program is limited to 20 groups and 50 variables maximum. The size of the groups need not be equal, although this is somewhat desirable. The total number of subjects should be greater than the number of variables selected. The number of selected variables will, in general, be less than (usually $\frac{1}{4}$-$\frac{1}{2}$ of) the number of variables on input. Chi-square criterion for selection should allow the number of selected variables to be greater than the number of groups and should be so adjusted. The general rule of thumb is

$$\text{groups} < \text{variables selected} < \text{total subjects}.$$

The discriminant functions are derived by a solution of the eigenvalue-eigenvector problem. The resultant functions are equal in number to the number of variables selected or one less than the number of groups, whichever is smaller. The statistical significance of a function can be tested by a chi-square test (Reference 1, pp.371–378) on the associated root. It is noted, however, that there is often practical use for functions that do not have statistical significance.

continued

This program is not equipped to handle missing data as there has been no standard procedure devised for this case. If necessary, the mean of the variable across the total sample may be used in place of the missing scores on a variable if they are not too numerous.

Job Deck Structure

Job card
LIBRARY (EIDISC)
LGO.
7-8-9 EOR

(a) Problem card for first analysis
(b) Variable-name cards for first analysis
(c) Group card for first group
(d) Group-title card for first group
(e) Variable-format cards for first group (3 required)
(f) Subject score cards (data cards) for first group

Items (c) through (f) are repeated for as many groups as there are in the first analysis. Then,

(g) The variable format (3 cards) for the ungrouped subjects. If *none are present use 3 blank cards.*
(h) The set of ungrouped subject score cards if present.

Items (a) through (h) can be repeated as often as desired for a second analysis (new input as the program will not reprocess the data from the previous analysis), a third analysis, etc.

6-7-8-9 EOI

REFERENCES

1. Rao, C. R., *Advanced Statistical Methods in Biometric Research* (John Wiley & Sons, Inc., New York, 1952), Chaps. 7–9.

SAMPLE INPUT

```
VLOBR,CH[redacted],CM111600.   EIDISC
LIBRARY(EIDISC,SETPLOT)
LGO.
03350110111.2599.    3
SIZVLLSIZVLMPOPVLLPCPVLMPDENVMPCEMVMPGHOWHFINSTALIT10PLIT105PRESCOPRESIN
NEWCIRRELMUSRELMIXRELMI2RELMI3RELCHMRELCAMLINHOMLINWHOLIBERACOLRAFINDCBI
IDEDEVIDETRASFCEXNSECEXTSECEXMINAANOINAGEXOMPAQUONPADMAFTRENVERPOWHORPOW
3500010
GROUP ONE COUNTRIES WITH AN ACTUAL COUP OR COUPS
(A6/20X4F1.0,X3F1.0/4XF1.0,5XF1.0,2X3F1.0,3XF1.0,2X4F1.0,2X2F1.0,X3F1.0/
8X2F1.0,6XF1.0,2XF1.0/6X3F1.0,10XF1.0,8XF1.0,4X2F1.0/7XF1.0,17XF1.0)

CONLEO
222242422112222441141121222222112212 CONGO(LEO)                       1 023
222212222224422112222221224244421222 CONGO(LEO)                       2 023
222222244442222212221226166222261466 CONGO(LEO)                       3 023
626222111222211111111111126121622222 CONGO(LEO)                       4 023
212412224412222421222333211112121 66 CONGO(LEO)                       5 023
CAFRRE
222242422112222441142122222222112222 CEN AFR REP                      1 016
222222222224422212222222222424431222 CEN AFR REP                      2 016
222222241242222212221222121266222122 CEN AFR REP                      3 016
222222222222666111211222551111122212 CEN AFR REP                      4 016
222142214426664421222421222222122422 CEN AFR REP                      5 016
BURUND
222242422112222441142222211221122222 BURUNDI                          1 012
222222222224422212222225224244451115 BURUNDI                          2 012
222222244442222212221225155266651442 BURUNDI                          3 012
121555222222666111221222551111222221 BURUNDI                          4 012
222442214426664525222555224212211122 BURUNDI                          5 012
GHANA
222242422112222441142121222121112222 GHANA                            1 039
222212222214212212212222221424421222 GHANA                            2 039
222222241142222212221112121211122122 GHANA                            3 039
222421421222111111211222551111122212 GHANA                            4 039
222141224424214421421111222222122422 GHANA                            5 039
NIGERI
222242422112222441141111211222212212 NIGERIA                          1 077
222212222214212112222222221424421222 NIGERIA                          2 077
222222241142222222223221114266631466 NIGERIA                          3 077
626222111222211111211111211222122122 NIGERIA                          4 077
212412224416664222333333211212211121 NIGERIA                          5  77
SUDAN
222242422112222441141121222222112222 SUDAN                            1 094
222212222224422212222222212424422222 SUDAN                            2 094
222222241142211112221212121222222266 SUDAN                            3 094
622421111222111111111666266622622222 SUDAN                            4 094
222162226466666466666622222222662666 SUDAN                            5  9
RWANDA
222242422112222441142222211221122222 RWANDA                           1 087
222222222224422212222225224244451115 RWANDA                           2 087
222222244442222212221225155266651462 RWANDA                           3 087
621555222222666111111221551211222221 RWANDA                           4 087
222442214426664525333555224211224222 RWANDA                           5 087
TOGC
222242422112222441142222222222112222 TOGO                             1 1
222222222224422212222221224244421222 TOGO                             2 100
222222241242222212221226166226666666 TOGO                             3 100
666421421222666111211221666226222122 TOGO                             4 100
222162214426664666222666222222622666 TOGO                             5 100
UGANDA
222242422112222441142121222222112222 UGANDA                           1 104
222222222224421112222221224244421222 UGANDA                           2 104
222222241142222222223221114266631411 UGANDA                           3 104
111222111222211111211111211222122122 UGANDA                           4 104
212412224416664222333333115552211121 UGANDA                           5 104
UPPVOL
222242422112222441142122222121112222 UPPER VOLTA                      1 109
222222222224422212222222212424421222 UPPER VOLTA                      2 109
222222241242222212221225155266221142 UPPER VOLTA                      3 109
122222222222266611121122255111122212 UPPER VOLTA                      4 109
222142214426664421222421222222122422 UPPER VOLTA                      5 109
```

continued

```
3500006
GROUP TWO COUNTRIES WITH AN ATTEMPTED COUP
(A6/20X4F1.0,X3F1.0/4XF1.0,5XF1.0,2X3F1.0,3XF1.0,2X4F1.0,2X2F1.0,X3F1.0/
8X2F1.0,6XF1.0,2XF1.0/6X3F1.0,10XF1.0,8XF1.0,4X2F1.0/7XF1.0,17XF1.0)

CONBRA
22224242211222244114212222212112222 CONGO(BRA)                      1 022
22222222222442221222222122424421222 CONGO(BRA)                      2 022
22222224124222221222122515526622142 CONGO(BRA)                      3 022
12122242122266611121122255111122221 CONGO(BRA)                      4 022
22244221442666442122242122222122422 CONGO(BRA)                      5 022
ETHIOP
22224242211222244114112122252112212 ETHIOPIA                        1 033
22221222222442221222222222142442222 ETHIOPIA                        2 033
11122444444414212221222221212122132 ETHIOPIA                        3 033
32222242122211111121144444422222222 ETHIOPIA                        4 033
22144444442444444411111122222222422 ETHIOPIA                        5 033
GABON
22224242211222244114212222222112222 GABON                           1 036
22222222222442221222222122424421222 GABON                           2 036
22222224124222221222122515526622122 GABON                           3 036
22122242122266611121122255111122212 GABON                           4 036
22214221442666442122242122222122422 GABON                           5 036
SENEGA
22224242211222244114212222212112222 SENEGAL                         1 089
22221222222442221222121222422211222 SENEGAL                         2 089
22222224124222221222121616622622142 SENEGAL                         3 089
12642142122221111121122211111122212 SENEGAL                         4 089
22214122442421422222242122222122422 SENEGAL                         5 089
SIELEO
22224242211222244114222222212112222 SIERRE LEO                      1 090
22222222222442111222222221424421222 SIERRE LEO                      2 090
22222224114222221222122111426611411 SIERRE LEO                      3 090
11142142122266611121121122121122122 SIERRE LEO                      4 090
12222221442222422242122222421221121 SIERRE LEO                      5 090
TANGAN
22224242211222244114112122222112222 TANGANYIKA                      1 098
22222222222442111222222221424421222 TANGANYIKA                      2 098
22222224114222221222121515526621442 TANGANYIKA                      3 098
12142122222221111122122211111122212 TANGANYIKA                      4 098
22214122442111422222211122222322322 TANGANYIKA                      5 098
```

continued

```
3500006
GROUP THREE COUNTRIES WITH NO CCUPS OR ATTEMPTED COUPS OVER THE PERIOD
(A6/20X4F1.0,X3F1.0/4XF1.0,5XF1.0,2X3F1.0,3XF1.0,2X4F1.0,2X2F1.0,X3F1.0/
8X2F1.0,6XF1.0,2XF1.0/6X3F1.0,10XF1.0,8XF1.0,4X2F1.0/7XF1.0,17XF1.0)

CAMERO
2222424221122224411421222222112222 CAMEROUN                                 1 014
2222222222244211122222222142442122 CAMEROUN                                 2 014
2222222412422222122212211162663146 CAMEROUN                                 3 014
6214214212226661112112112111122121 CAMEROUN                                 4 014
2224422244166644212224211142112242 CAMEROUN                                 5 014
CHAD
2222424221122224411411222221211222 CHAD                                     1 018
2222222222244211122222221242442222 CHAD                                     2 018
2222222412422222122212251552662214 CHAD                                     3 018
1212224212226661112112225511112221 CHAD                                     4 018
2221422144266644212224212222222222 CHAD                                     5 018
GUINEA
2222424221122224411421222221211222 GUINEA                                   1 042
2222222222545522122222221242442122 GUINEA                                   2 042
2222222412422222122211121212112212 GUINEA                                   3 042
2224214212221111121122255111122212 GUINEA                                   4 042
2221412244211142224211112222212242 GUINEA                                   5 042
LIBERIA
2222424221122224411422222222211222 LIBERIA                                  1 062
2222222221222211222222122424421222 LIBERIA                                  2  62
2112244444221222222322212111121422 LI25991                                  3 062
2222224212221112112212112112212221 LIBERIA                                  4 062
2221423244211144211112222222212242 LIBERIA                                  5 062
MALI
2222424221122224411411222221211222 MALI                                     1 067
2222222222244211122222221242442222 MALI                                     2 067
2222222412422222122212251552662212 MALI                                     3 067
2225552112226661112112225511112221 MALI                                     4 067
2221422144266644212224212242122242 MALI                                     5 067
SOMALIA
2222424221122224411421222222211222 SOMALIA                                  1 091
2222222222244211122212122242221111 SOMALIA                                  2 091
2222222444422222122212211152663144 SOMALIA                                  3 091
1214211112226661112112112212212222 SOMALIA                                  4 091
2224422244122242224212222242121212 SOMALIA                                  5 091
(A6/20X4F1.0,X3F1.0/4XF1.0,5XF1.0,2X3F1.0,3XF1.0,2X4F1.0,2X2F1.0,X3F1.0/
8X2F1.0,6XF1.0,2XF1.0/6X3F1.0,10XF1.0,8XF1.0,4X2F1.0/7XF1.0,17XF1.0)

DAHCMEY
2222424221122224411422222222211222 DAHOMEY                                  1 028
2222222222244222122222222142442122 DAHOMEY                                  2 028
2222222412422222122212251552662212 DAHOMEY                                  3 028
2222224212226661112112225511112221 DAHOMEY                                  4 028
2221422144266644212224212222212242 DAHOMEY                                  5 028
NIGER
2222424221122224411411222221211222 NIGER                                    1 076
2222222222244211122222221242442222 NIGER                                    2 076
2222222412422222122212251552662216 NIGER                                    3 076
6222221112226661112112225511112221 NIGER                                    4 076
2221422144266644212224212222212242 NIGER                                    5 076
IVOCOS
2222424221122224411421222221211222 IVORY COAST                              1 054
2222222222244222122222222142442122 IVORY COAST                              2 054
2222222412422222122212131332662212 IVORY COAST                              3 054
2224212222222111112112225511112221 IVORY COAST                              4 054
2221412244242144212221112222212242 IVORY COAST                              5 054
```

SAMPLE OUTPUT

```
MULTIPLE DISCRIMINANT ANALYSIS

NO. OF GROUPS =  3

NO. OF VARIABLES = 35


CORRELATION ANALYSIS FOR GROUP ONE COUNTRIES WITH AN ACTUAL COUP OR COUPS

NUMBER OF VARIABLES =  35

NUMBER OF SUBJECTS IN THIS GROUP =     10

          .
          .
          .

          .


CORRELATION ANALYSIS FOR GROUP TWO COUNTRIES WITH AN ATTEMPTED COUP

NUMBER OF VARIABLES =  35

NUMBER OF SUBJECTS IN THIS GROUP =      6

          .
          .
          .

          .


CORRELATION ANALYSIS FOR GROUP THREE COUNTRIES WITH NO COUPS OR ATTEMPTED COUPS OVER THE PERIOD

NUMBER OF VARIABLES =  35

NUMBER OF SUBJECTS IN THIS GROUP =      6

          .
          .
          .
```

continued

```
CORRELATION MATRIX. GROUP THREE COUNTRIES WITH NO COUPS OR ATTEMPTED COUPS OVER THE PERIOD  N=  6       PAGE NO.  1

R MAT    SECTION  1

  VAR           SIZVLL     SIZVLM     POPVLL     POPVLM     PDENVM     PDEMVM     PGROWH     FINSTA     LIT10P     LIT105
MEANS            1.667      1.167      2.000      2.000      2.000      2.000      1.500      2.000      2.333      2.500
ST.DEV            .516       .408      0.000      0.000      0.000      0.000       .548      0.000      1.366      1.225


SIZVLL  1        1.000       .316      0.000      0.000      0.000      0.000       .707      0.000       .189       .316
SIZVLM  2         .316      1.000      0.000      0.000      0.000      0.000       .447      0.000      -.478      -.200
POPVLL  3        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
POPVLM  4        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
PDENVM  5        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
PDEMVM  6        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
PGROWH  7         .707       .447      0.000      0.000      0.000      0.000      1.000      0.000      -.535      -.447
FINSTA  8        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
LIT10P  9         .189      -.478      0.000      0.000      0.000      0.000      -.535      0.000      1.000       .956
LIT105 10         .316      -.200      0.000      0.000      0.000      0.000      -.447      0.000       .956      1.000
PRESCO 11         .500       .632      0.000      0.000      0.000      0.000      0.000      0.000       .378       .632
PRESIN 12         .316      -.200      0.000      0.000      0.000      0.000      -.447      0.000       .956      1.000
NEWCIR 13        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
RELMUS 14        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
RELMIX 15        -.316     -1.000      0.000      0.000      0.000      0.000      -.447      0.000       .478       .200
RELMI2 16         .707       .447      0.000      0.000      0.000      0.000      1.000      0.000      -.535      -.447
RELMI3 17        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
RELCHM 18        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
RELCAM 19        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
LINHOM 20       -1.000      -.316      0.000      0.000      0.000      0.000      -.707      0.000      -.189      -.316
LINWHO 21        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
LIBERA 22        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
COLRAF 23         .500       .632      0.000      0.000      0.000      0.000       .707      0.000      -.472      -.316
INDCRI 24         .500       .632      0.000      0.000      0.000      0.000       .707      0.000      -.472      -.316
IDEDEV 25         .316      1.000      0.000      0.000      0.000      0.000       .447      0.000      -.478      -.200
IDETRA 26        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
SFCEXN 27         .097       .307      0.000      0.000      0.000      0.000      -.137      0.000       .189       .307
SFCEXT 28         .250       .316      0.000      0.000      0.000      0.000      0.000      0.000       .189       .316
SFCEXM 29        0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000      0.000
INAANO 30         .316      1.000      0.000      0.000      0.000      0.000       .447      0.000      -.478      -.200
INAGEX 31         .500       .632      0.000      0.000      0.000      0.000       .707      0.000      -.472      -.316
ONPAQU 32         .500      -.316      0.000      0.000      0.000      0.000       .707      0.000      -.189      -.316
ONPADM 33        -.500       .316      0.000      0.000      0.000      0.000      -.707      0.000       .189       .316
AFTREN 34        1.000       .316      0.000      0.000      0.000      0.000       .707      0.000       .189       .316
VERPOW 35        -.316       .200      0.000      0.000      0.000      0.000      -.447      0.000       .120       .200
```

continued

```
R MAT   SECTION  2

  VAR          PRESCO    PRESIN    NEWCIR    RELMUS    RELMIX    RELMI2    RELMI3    RELCHM    RELCAM    LINHOM
MEANS           1.333     1.167     2.000     1.833     1.833     1.500     1.833     3.667     3.667     1.333
ST.DEV           .516      .408     0.000      .408      .408      .548      .408      .816      .816      .516


SIZVLL  1        .500      .316     0.000     -.316     -.316      .707     -.316     -.316     -.316    -1.000
SIZVLM  2        .632     -.200     0.000      .200    -1.000      .447      .200      .200      .200     -.316
POPVLL  3       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
POPVLM  4       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PDEKVM  5       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PDENVM  6       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PGROWH  7       0.000     -.447     0.000     -.447     -.447     1.000     -.447     -.447     -.447     -.707
FINSTA  8       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
LIT10P  9        .378      .956     0.000      .120      .478     -.535      .120      .120      .120     -.189
LIT105 10        .632     1.000     0.000      .200      .200     -.447      .200      .200      .200     -.316
PRESCO 11       1.000      .632     0.000      .316     -.632     0.000      .316      .316      .316     -.500
PRESIN 12        .632     1.000     0.000      .200      .200     -.447      .200      .200      .200     -.316
NEWCIR 13       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
RELMUS 14        .316      .200     0.000     1.000     -.200     -.447     -.200     1.000     1.000      .316
RELMIX 15       -.632      .200     0.000     -.200     1.000     -.447     -.200     -.200     -.200      .316
RELMI2 16       0.000     -.447     0.000     -.447     -.447     1.000     -.447     -.447     -.447     -.707
RELMI3 17        .316      .200     0.000     -.200     -.200     -.447     1.000     -.200     -.200      .316
RELCHM 18        .316      .200     0.000     1.000     -.200     -.447     -.200     1.000     1.000      .316
RELCAM 19        .316      .200     0.000     1.000     -.200     -.447     -.200     1.000     1.000      .316
LINHOM 20       -.500     -.316     0.000      .316      .316     -.707      .316      .316      .316     1.000
LINWHO 21        .316      .200     0.000     1.000     -.200     -.447     -.200     1.000     1.000      .316
LIBERA 22        .316      .200     0.000     1.000     -.200     -.447     -.200     1.000     1.000      .316
COLBAF 23        .250     -.316     0.000     -.632     -.632      .707      .316     -.632     -.632     -.500
INDCRI 24        .250     -.316     0.000     -.632     -.632      .707      .316     -.632     -.632     -.500
IDEDEV 25        .632     -.200     0.000      .200    -1.000      .447      .200      .200      .200     -.316
IDETRA 26       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
SECEXN 27        .486      .307     0.000      .799     -.307     -.137     -.307      .799      .799     -.097
SECEXT 28        .500      .316     0.000      .632     -.316     0.000     -.316      .632      .632     -.250
SECEXM 29       0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
INAANO 30        .632     -.200     0.000      .200    -1.000      .447      .200      .200      .200     -.316
INAGEX 31        .250     -.316     0.000     -.632     -.632      .707      .316     -.632     -.632     -.500
OMPAQU 32       -.500     -.316     0.000     -.632      .316      .707     -.632     -.632     -.632     -.500
ONPADM 33        .500      .316     0.000      .632     -.316     -.707      .632      .632      .632      .500
AFTREN 34        .500      .316     0.000     -.316     -.316      .707     -.316     -.316     -.316    -1.000
VERPOW 35        .316      .200     0.000     -.200     -.200     -.447     1.000     -.200     -.200      .316
```

continued

```
R MAT   SECTION  3

  VAR           LINWHO    LIBERA    COLBAF    INDCRI    IDEDEV    IDETRA    SECEXN    SECEXT    SECEXM    INAANO
MEANS            1.833     1.833     2.000     2.667     1.167     2.000     3.167     1.667     1.000     1.167
ST.DEV            .408      .408     1.549     1.033      .408     0.000     1.329      .516     0.000      .408


SIZVLL  1        -.316     -.316      .500      .500      .316     0.000      .097      .250     0.000      .316
SIZVLM  2         .200      .200      .632      .632     1.000     0.000      .307      .316     0.000     1.000
POPVLL  3        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
POPVLM  4        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PDENVM  5        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PDEWVM  6        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
PGRCWH  7        -.447     -.447      .707      .707      .447     0.000     -.137     0.000     0.000      .447
FINSTA  8        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
LITIOP  9         .120      .120     -.472     -.472     -.478     0.000      .184      .189     0.000     -.478
LITIO5 10         .200      .200     -.316     -.316     -.200     0.000      .307      .316     0.000     -.200
PRESCO 11         .316      .316      .250      .250      .632     0.000      .486      .500     0.000      .632
PRESIN 12         .200      .200     -.316     -.316     -.200     0.000      .307      .316     0.000     -.200
NEWCIR 13        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
RELMUS 14        1.000     1.000     -.632     -.632      .200     0.000      .799      .632     0.000      .200
RELMIX 15        -.200     -.200     -.632     -.632    -1.000     0.000     -.307     -.316     0.000    -1.000
RELMI2 16        -.447     -.447      .707      .707      .447     0.000     -.137     0.000     0.000      .447
RELMI3 17        -.200     -.200      .316      .316      .200     0.000     -.307     -.316     0.000      .200
RELCHM 18        1.000     1.000     -.632     -.632      .200     0.000      .799      .632     0.000      .200
RELCAM 19        1.000     1.000     -.632     -.632      .200     0.000      .799      .632     0.000      .200
LINHOM 20         .316      .316     -.500     -.500     -.316     0.000     -.097     -.250     0.000     -.316
LINWHO 21        1.000     1.000     -.632     -.632      .200     0.000      .799      .632     0.000      .200
LIBERA 22        1.000     1.000     -.632     -.632      .200     0.000      .799      .632     0.000      .200
COLBAF 23        -.632     -.632     1.000     1.000      .632     0.000     -.389     -.250     0.000      .632
INDCRI 24        -.632     -.632     1.000     1.000      .632     0.000     -.389     -.250     0.000      .632
IDEDEV 25         .200      .200      .632      .632     1.000     0.000      .307      .316     0.000     1.000
IDETRA 26        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
SECEXN 27         .799      .799     -.389     -.389      .307     0.000     1.000      .971     0.000      .307
SECEXT 28         .632      .632     -.250     -.250      .316     0.000      .971     1.000     0.000      .316
SECEXM 29        0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
INAANO 30         .200      .200      .632      .632     1.000     0.000      .307      .316     0.000     1.000
INAGEX 31        -.632     -.632     1.000     1.000      .632     0.000     -.389     -.250     0.000      .632
OMPAQU 32        -.632     -.632      .250      .250     -.316     0.000     -.389     -.250     0.000     -.316
ONPADM 33         .632      .632     -.250     -.250      .316     0.000      .389      .250     0.000      .316
AFTREN 34        -.316     -.316      .500      .500      .316     0.000      .097      .250     0.000      .316
VERPOW 35        -.200     -.200      .316      .316      .200     0.000     -.307     -.316     0.000      .200
```

continued

000 0010

```
R MAT    SECTION  4

  VAR              INAGEX      OMPAQU      ONPADM      AFTREN      VERPOW
MEANS               1,333       1,333       1.667       1.667       1.833
ST.DEV               ,516        ,516        .516        .516        .408


STZVLL  1            ,500        ,500       -.500       1.000       -.316
STZVLM  2            ,632       -,316        .316        .316        .200
POPVLL  3           0,000       0.000       0.000       0.000       0.000
POPVLM  4           0,000       0.000       0.000       0.000       0.000
PDEAVM  5           0,000       0.000       0.000       0.000       0.000
PDEWVM  6           0,000       0.000       0.000       0.000       0.000
PGRCWH  7            ,707        ,707       -.707        .707       -.447
FINSTA  8           0,000       0.000       0.000       0.000       0.000
LIT10P  9           -,472       -,189        .189        .189        .120
LIT105 10           -,316       -,316        .316        .316        .200
PRESCO 11            ,250       -,500        .500        .500        .316
PRESIN 12           -,316       -,316        .316        .316        .200
NEWCIR 13           0,000       0.000       0.000       0.000       0.000
RELMUS 14           -,632       -,632        .632       -.316       -.200
RELMIX 15           -,632        ,316       -.316       -.316       -.200
RELMI2 16            ,707        ,707       -.707        .707       -.447
RELMI3 17            ,316       -,632        .632       -.316       1.000
RELCHM 18           -,632       -,632        .632       -.316       -.200
RELCAM 19           -,632       -,632        .632       -.316       -.200
LINHOM 20           -,500       -,500        .500      -1.000        .316
LINWHO 21           -,632       -,632        .632       -.316       -.200
LIBERA 22           -,632       -,632        .632       -.316       -.200
COLBAF 23           1,000        ,250       -.250        .500        .316
INDCRI 24           1,000        ,250       -.250        .500        .316
IDEDEV 25            ,632       -,316        .316        .316        .200
IDETRA 26           0,000       0.000       0.000       0.000       0.000
SECEXN 27           -,389       -,389        .389        .097       -.307
SECEXT 28           -,250       -,250        .250        .250       -.316
SECEXM 29           0,000       0.000       0.000       0.000       0.000
INAANO 30            ,632       -,316        .316        .316        .200
INAGEX 31           1,000        ,250       -.250        .500        .316
OMPAQU 32            ,250       1.000      -1.000        .500       -.632
ONPADM 33           -,250      -1.000       1.000       -.500        .632
AFTREN 34            ,500        .500       -.500       1.000       -.316
VERPOW 35            ,316       -,632        .632       -.316       1.000
```

continued

```
POOLED W MATRIX

W MAT   SECTION  1

  VAR          SIZVLL     SIZVLM     POPVLL     POPVLM     PDENVM     PDEMVM     PGROWH     FINSTA     LITIOP     LIT105


STZVLL  1       4.767      1.567       .700      2.833       .100       .100     -2.600      2.133      1.067      1.400
STZVLM  2       1.567      3.767       .300      1.833     -1.100     -1.100       .100      1.533      -.733       .100
POPVLL  3        .700       .300       .900       .500       .700       .700      -.200       .600       .800       .800
POPVLM  4       2.833      1.833       .500      3.833      -.500      -.500     -3.000      2.333      1.000      1.000
PDENVM  5        .100     -1.100       .700      -.500      2.100      2.100      -.600      -.200       .400       .400
PDEMVM  6        .100     -1.100       .700      -.500      2.100      2.100      -.600      -.200       .400       .400
PGRCWH  7      -2.600       .100      -.200     -3.000      -.600      -.600     15.100     -1.800     -1.400      -.900
FINSTA  8       2.133      1.533       .600      2.333      -.200      -.200     -1.800      3.733      1.200      1.200
LITIOP  9       1.067      -.733       .800      1.000       .400       .400     -1.400      1.200     10.933      9.600
LITI05 10       1.400       .100       .800      1.000       .400       .400      -.900      1.200      9.600      9.100
PRESCO 11        .700       .300      -.100       .833      -.300      -.300       .800     -1.067      1.133      1.800
PRESIN 12       1.767       .067       .700      1.833       .100       .100      -.100       .133      3.067      2.900
NEWCTR 13       -.300       .300      -.100       .500      -.300      -.300       .800       .500       .800       .800
RFLMUS 14       -.667       .333      0.000      -.333      0.000      0.000       .500       .667       .333       .500
RFLMIX 15        .900      3.600       .300      2.833     -5.100     -5.100      1.100      1.533      1.933      1.100
RFLMI2 16       1.400      1.100      -.200      0.000      -.600      -.600      2.100       .200     -2.400     -1.900
RFLMI3 17       1.067       .267       .800      2.000       .400       .400     -1.900      1.200      1.933      2.100
RFLCHM 18      -1.333       .667      0.000      -.667      0.000      0.000      1.000      1.333       .667      1.000
RFLCAM 19      -1.333       .667      0.000      -.667      0.000      0.000      1.000      1.333       .667      1.000
LINHOM 20      -2.700      -.800       .100     -1.167       .300       .300      2.200     -1.267      -.467      -.800
LINWHO 21       -.933     -1.233      -.200     -1.000      1.400      1.400      -.900      -.400      -.067       .100
LIBERA 22       -.933     -1.233      -.200     -1.000      1.400      1.400      -.900      -.300      -.067       .100
COLBAF 23       -.300      4.800       .900      -.500     -3.300     -3.300     13.800     -1.400     -4.200     -1.200
INDCRI 24        .933      3.733      1.200      2.000     -2.400     -2.400     10.400      -.200      -.933       .400
IDEDEV 25       -.733       .067      -.800     -1.667      -.400      -.400      3.900      -.367     -1.933     -1.100
IDETRA 26        .667       .167      0.000       .667      0.000      0.000     -3.000       .667      0.000      0.000
SECEXN 27       4.667      3.167      1.000      3.333      1.000      1.000     -2.500       .333       .667      1.500
SECEXT 28       2.133      1.533       .600      2.000      -.200      -.200      -.800      1.400       .867      1.200
SECEXM 29        .533       .633       .400      1.333      -.800      -.800      -.200      1.933       .800       .800
INAANO 30       -.033      1.367       .100      -.167      -.700      -.700       .700       .733     -1.133      -.300
INAGEX 31       -.800       .300      -.600     -1.667       .200       .200      4.800     -1.067     -1.067     -1.200
OMPAQU 32       -.533       .367      -.400     -1.000     -1.200     -1.200      3.200      -.600      -.467      -.800
ONPADM 33      -1.600      -.900      -.200     -1.333      1.400      1.400      -.400     -1.133       .267       .600
AFTREN 34      -2.500     -2.000      -.500     -4.833       .500       .500      4.000     -4.333      -.333      0.000
VERPOW 35        .767      1.067       .700      1.500       .100       .100     -1.100       .800       .733       .900
```

continued

```
W MAT   SECTION  2

  VAR            PRESCO     PRESIN     NEWCIR     RELMUS     RFLMIX     RFLMI2     RFLMI3     RFLCHM     RFLCAM     LINHOM


SIZVLL  1          .700      1.767      -.300      -.667       .900      1.400      1.067     -1.333     -1.333     -2.700
SIZVLM  2          .300       .067       .300       .333      3.600      1.100       .267       .667       .667      -.800
POPVLL  3         -.100       .700      -.100      0.000       .300      -.200       .800      0.000      0.000       .100
POPVLM  4          .833      1.833       .500      -.333      2.833      0.000      2.000      -.667      -.667     -1.167
PDEAVM  5         -.300       .100      -.300      0.000     -5.100      -.600       .400      0.000      0.000       .300
PDENVM  6         -.300       .100      -.300      0.000     -5.100      -.600       .400      0.000      0.000       .300
PGROWH  7          .800      -.100       .800       .500      1.100      2.100     -1.900      1.000      1.000      2.200
FINSTA  8        -1.067       .133       .600       .667      1.533       .200      1.200      1.333      1.333     -1.267
LIT10P  9         1.133      3.067       .800       .333      1.933     -2.400      1.933       .667       .667      -.467
LIT105 10         1.800      2.900       .800       .500      1.100     -1.900      2.100      1.000      1.000      -.800
PRESCO 11         3.567      2.700      -.100       .000      -.033      -.200      1.133       .000       .000      -.233
PRESIN 12         2.700      4.267      -.300      -.167      2.400     -1.100      1.567      -.333      -.333       .300
NEWCIR 13         -.100      -.300       .900      0.000       .300      -.200       .800      0.000      0.000       .100
RFLMUS 14          .000      -.167      0.000      1.667      -.500      -.500      -.667      3.333      3.333       .500
RFLMIX 15         -.033      2.400       .300      -.500     22.267       .100      -.567     -1.000     -1.000       .367
RFLMI2 16         -.200     -1.100      -.200      -.500       .100      3.100      -.900     -1.000     -1.000     -1.800
RFLMI3 17         1.133      1.567       .800      -.667      -.567      -.900      3.933     -1.333     -1.333       .033
RFLCHM 18          .000      -.333      0.000      3.333     -1.000     -1.000     -1.333      6.667      6.667      1.000
RFLCAM 19          .000      -.333      0.000      3.333     -1.000     -1.000     -1.333      6.667      6.667      1.000
LINHOM 20         -.233       .300       .100       .500       .367     -1.800       .033      1.000      1.000      3.067
LINWHO 21          .133      -.433      -.200       .833     -5.567      -.900      -.567      1.667      1.667       .533
LIBERA 22          .133      -.433      -.200       .833     -5.567      -.900      -.567      1.667      1.667       .533
COLRAF 23         2.900      -.300       .900     -1.500     11.300      4.800      1.300     -3.000     -3.000      -.400
INDCRI 24         3.867      1.933      1.200     -1.333      9.067      3.400      3.067     -2.667     -2.667      -.533
IDEDEV 25          .200     -1.233       .200       .333     -2.100       .900      -.933       .667       .667       .300
IDETRA 26         -.333      -.333      0.000      -.167      -.333      0.000       .500      -.333      -.333      -.833
SECEXN 27         4.000      5.167     -2.000      1.833     -1.500       .500      -.833      3.667      3.667     -1.000
SECEXT 28         1.267      2.133      -.400       .667      2.867       .200      -.133      1.333      1.333      -.933
SECEXM 29         -.267       .533       .400       .167      5.133      -.200       .300       .333       .333      -.567
INAANO 30          .100      -.533       .100       .333      2.200       .700      -.133       .667       .667      -.600
INAGEX 31          .067      -.800       .400      -.500     -3.533       .800      -.367     -1.000     -1.000       .767
OMPAQU 32        -1.067     -1.533       .600      -.167      2.533      1.200      -.967      -.333      -.333       .233
ONPADM 33          .133      -.600      -.200       .500     -5.067     -1.400      -.233      1.000      1.000      1.033
AFTREN 34          .833      -.500      -.500      -.500     -2.167      1.000     -2.833     -1.000     -1.000      1.333
VERPOW 35         1.033      2.267      -.300      -.167      2.733     -1.100      1.233      -.333      -.333       .633
```

continued

```
 MAT   SECTION  3
 VAR            LINWHO     LIBERA     COLBAF     INDCRI     IDEDEV     IDETRA     SFCEXN     SFCEXT     SFCEXM     INAANO

STZVLL  1        -,933      -,933      -.300       .933      -.733       .667      4.667      2.133       .533      -.033
STZVLM  2       -1,233     -1,233      4.800      3.733       .067       .167      3.167      1.533       .633      1.367
POPVLL  3        -,200      -,200       .900      1.200      -.800      0.000      1.000       .600       .400       .100
POPVLM  4       -1,000     -1,000      -.500      2.000     -1.667       .667      3.333      2.000      1.333      -.167
PDEKVM  5        1,400      1,400     -3.300     -2,400      -.400      0.000      1.000      -.200      -.800      -.700
PDEMVM  6        1,400      1,400     -3.300     -2,400      -.400      0.000      1.000      -.200      -.800      -.700
PGRCWH  7        -,900      -,900     13.800     10.400      3.900     -3.000     -2.500      -.400      -.200       .700
FINSTA  8        -,800      -,800     -1.400      -.200      -.867       .667       .333      1.400      1.933       .733
LIT10P  9        -,067      -,067     -3.200      -.933     -1.933      0.000       .667       .867       .800     -1.133
 IT105 10         .100       .100     -1.200       .400     -1.100      0.000      1.500      1.200       .900      -.300
  ESCO 11         .133       .133      2.900      3.867       .200      -.333      4.000      1.267      -.267       .100
 PESIN 12        -,433      -,433      -.300      1.933     -1.233      -.333      5.167      2.133       .533      -.533
NEWCIR 13        -,200      -,200       .900      1.200       .200      0.000     -2.000      -.400       .400       .100
RFLMUS 14         .833       .833     -1.500     -1.333       .333      -.167      1.833       .667       .167       .333
RFLMIX 15       -5,567     -5,567     11.300      9.067     -2.100      -.333     -1.500      2.467      5.133      2.200
RFLMI2 16        -,900      -,900      4.800      3.400       .900      0.000       .500       .200      -.200       .700
RFLMI3 17        -,567      -,567      1.300      3.067      -.933       .500      -.833      -.133       .300      -.133
RFLCHM 18        1,667      1,667     -3.000     -2.667       .667      -.333      3.667      1.333       .333       .667
RFLCAM 19        1,667      1,667     -3.000     -2.667       .667      -.333      3.667      1.333       .333       .667
LINHOM 20         .533       .533      -.400      -.533       .300      -.833     -1.000      -.933      -.567      -.600
LINWHO 21        2.433      2.433     -6.200     -4.933       .567      0.000      2.167      -.133     -1.200      -.633
LIBERA 22        2.433      2.433     -6.200     -4.933       .567      0.000      2.167      -.133     -1.200      -.633
COLBAF 23       -6,200     -6,200     38.400     30.200      2.700     -2.500     -6.000      -.400      1.900      3.600
INDCRI 24       -4,933     -4,933     30.200     26.933       .933     -2.000     -1.667      1.133      2.200      2.133
IDEDEV 25         .567       .567      2.700       .933      3.267      -.833      -.833      -.367      -.467       .467
IDETRA 26        0.000      0.000     -2.500     -2.000      -.833       .833      -.333      0.000       .167       .167
SFCEXN 27        2.167      2.167     -6.000     -1.667      -.833      -.333     24.167      7.333     -1.067      -.833
SFCEXT 28        -,133      -.133      -.400      1.133      -.867      0.000      7.333      3.733      1.600       .733
SFCEXM 29       -1.200     -1.200      1.900      2.200      -.967       .167     -1.667      1.600      4.233      1.433
INAANO 30        -,633      -.633      3.600      2.133       .467       .167      -.833       .733      1.433      2.567
INAGEX 31         .133       .133      2.900       .867      2.700      -.633     -2.000     -1.733     -1.767       .100
OMPAQU 32       -1.467     -1.467      6.100      3.467       .967      -.500     -4.333     -1.133      -.900      -.433
ONPADM 33        2,267      2.267     -4.700     -4.267       .900      -.167      1.000      -.467     -1.033      -.300
AFTREN 34         .667       .667      7.000      3.333      3.500     -2.167     -2.000     -1.667     -1.833       .000
VERPOW 35        -,767      -.767       .700      1.267     -1.233      0.000      2.167      1.467      1.200       .467
```

continued

```
W MAT   SECTION  4
  VAR           INAGEX     OMPAQU      ONPADM      AFTREN      VERPOW


STZVLL  1        -.800      -.533      -1.600      -2.500        .767
STZVLM  2         .300       .367       -.900      -2.000       1.067
POPVLL  3        -.600      -.400       -.200       -.500        .700
POPVLM  4       -1.667     -1.000      -1.333      -4.833       1.500
PDENVM  5         .200     -1.200       1.400        .500        .100
PDEWVM  6         .200     -1.200       1.400        .500        .100
PGROWH  7        4.800      3.200       -.400       4.000      -1.100
FINSTA  8       -1.067      -.600      -1.133      -4.333        .800
LIT10P  9       -1.867      -.467        .267       -.333        .733
LIT105 10       -1.200      -.800        .600       0.000        .900
PRESCO 11         .067     -1.067        .133        .833       1.033
PRESIN 12        -.800     -1.533       -.600       -.500       2.267
NEWCIR 13         .400       .600       -.200       -.500       -.300
RFLMUS 14        -.500      -.167        .500       -.500       -.167
RFLMIX 15       -3.533      2.533      -5.067      -2.167       2.733
RFLMI2 16         .800      1.200      -1.400       1.000      -1.100
RFLMI3 17        -.367      -.967       -.233      -2.833       1.233
RFLCHM 18       -1.000      -.333       1.000      -1.000       -.333
RFLCAM 19       -1.000      -.333       1.000      -1.000       -.333
LINHOM 20         .767       .233       1.033       1.333        .633
LINWHO 21         .133     -1.467       2.267        .667       -.767
LIBERA 22         .133     -1.467       2.267        .667       -.767
COLBAF 23        2.900      6.100      -4.700       7.000        .700
INDCRI 24         .867      3.467      -4.267       3.333       1.267
IDEDEV 25        2.700       .967        .900       3.500      -1.233
IDETRA 26        -.833      -.500       -.167      -2.167       0.000
SECEXN 27       -2.000     -4.333       1.000      -2.000       2.167
SECEXT 28       -1.733     -1.933       -.467      -1.567       1.467
SECEXM 29       -1.767      -.900      -1.033      -1.833       1.200
INAANO 30         .100      -.433       -.300        .000        .467
INAGEX 31        4.567      1.433        .633       3.833       -.467
OMPAQU 32        1.433      5.233      -2.633       2.167      -1.867
ONPADM 33         .633     -2.633       3.767       1.167        .067
AFTREN 34        3.833      2.167       1.167      10.667      -1.833
VERPOW 35        -.467     -1.867        .067      -1.833       2.933
```

continued

```
TOTAL CORRELATION MATRIX      TOTAL NO. OF SUBJECTS =    22

TOT R   SECTION  1

  VAR           SIZVLL     SIZVLM     POPVLL     POPVLM     PDENVM     PDENVM     PGROWH     FINSTA     LIT10P     LIT105
MEANS            1.682      1.227      1.955      1.682      1.864      1.864      1.773      1.727      2.000      2.045
ST.DEV            .477       .429       .213       .477       .351       .351       .869       .456       .756       .722


SIZVLL  1        1.000       .370       .319       .581       .013       .013      -.298       .458       .132       .182
SIZVLM  2         .370      1.000       .118       .370      -.417      -.417       .017       .332      -.147      -.035
POPVLL  3         .319       .118      1.000       .319       .549       .549      -.058       .356       .295       .323
POPVLM  4         .581       .370       .319      1.000       .013       .013      -.413       .677       .264       .321
PDENVM  5         .013      -.417       .549       .013      1.000      1.000      -.106       .054       .179       .213
PDENVM  6         .013      -.417       .549       .013      1.000      1.000      -.106       .054       .179       .213
PGROWH  7        -.298       .017      -.058      -.413      -.106      -.106      1.000      -.284      -.145      -.134
FINSTA  8         .458       .332       .356       .677       .054       .054      -.284      1.000       .276       .329
LIT10P  9         .132      -.147       .295       .264       .179       .179      -.145       .276      1.000       .959
LIT105 10         .182      -.035       .323       .321       .213       .213      -.134       .329       .959      1.000
PRESCO 11         .162       .138      -.149      -.048      -.271      -.271       .162      -.418      0.000       .044
PRESIN 12         .356       .059       .239       .160      -.097      -.097       .078      -.149       .247       .188
NEWCIR 13        -.149       .118      -.046       .319      -.087      -.087       .199       .356       .295       .323
RELMUS 14        -.216       .171      -.069      -.216      -.126      -.126       .102       .161      0.000       .020
RELMIX 15         .093       .415      0.000       .197      -.761      -.761       .051       .098       .059      0.000
RELMI2 16         .328       .294      -.118      -.138      -.215      -.215       .366      -.089      -.441      -.426
RELMI3 17         .239       .089       .356       .458       .054       .054      -.284       .313       .276       .329
RELCHM 18        -.216       .171      -.069      -.216      -.126      -.126       .102       .161      0.000       .020
RELCAM 19        -.216       .171      -.069      -.216      -.126      -.126       .102       .161      0.000       .020
LINHOM 20        -.690      -.256       .103      -.184       .187       .187       .265      -.241      0.000      -.030
LINWHO 21        -.271      -.417      -.087      -.271       .614       .614      -.106      -.243      0.000       .026
LIBERA 22        -.271      -.417      -.087      -.271       .614       .614      -.106      -.243      0.000       .026
COLRAF 23        -.020       .399       .134      -.020      -.351      -.351       .524      -.083      -.138      -.039
INDCRI 24         .078       .347       .245       .250      -.255      -.255       .441       .057      0.000       .098
IDEDEV 25        -.184       .026      -.463      -.437      -.156      -.156       .543      -.241      -.319      -.197
IDETRA 26         .319       .118      -.048       .319      -.087      -.087      -.829       .356      0.000       .014
SFCEXN 27         .337       .181       .303       .413       .344       .344      -.090       .131       .145       .213
SFCEXT 28         .458       .332       .356       .458       .054       .054      -.044       .313       .138       .184
SFCEXM 29         .138       .224       .118       .138      -.417      -.417       .017       .332      0.000      -.035
INAANO 30        -.013       .417       .087      -.013      -.228      -.228       .106       .243      -.179      -.026
INAGEX 31        -.162       .095      -.319      -.371      -.013      -.013       .528      -.239      -.264      -.182
OMPAQU 32        -.098       .108      -.218      -.293      -.397      -.397       .375      -.204      -.123      -.193
ONPADM 33        -.370      -.224      -.118      -.370       .417       .417      -.017      -.332      0.000       .035
AFTREN 34        -.350      -.333      -.112      -.625       .170       .170       .692      -.601      0.000       .033
VERROW 35         .184       .256       .463       .437       .156       .156      -.126       .241       .160       .197
```

continued

```
TOT R   SECTION  2

  VAR             PRESCO    PRESIN    NEWCIR    RFLMUS    RFLMIX    RFLMI2    RFLMI3    RFLCHM    RFLCAM    LINHOM
MEANS              1.682     1.545     1.955     1.909     2.000     1.773     1.727     3.818     3.818     1.182
ST.DEV              .477      .510      .213      .294     1.049      .429      .456      .588      .583      .395


SIZVLL  1           .162      .356     -.149     -.216      .093      .329      .239     -.216     -.216     -.690
SIZVLM  2           .138      .059      .118      .171      .415      .294      .089      .171      .171     -.256
POPVLL  3          -.149      .239     -.048     -.069     0.000     -.118      .356     -.069     -.069      .103
POPVLM  4          -.048      .160      .319     -.216      .187     -.138      .458     -.216     -.216     -.184
PDEKVM  5          -.271     -.097     -.087     -.126     -.761     -.215      .054     -.126     -.126      .187
PDEWVM  6          -.271     -.097     -.087     -.126     -.761     -.215      .054     -.126     -.126      .187
PGRCWH  7           .162      .078      .199      .102      .051      .366     -.284      .102      .102      .265
FINSTA  8          -.418     -.149      .356      .161      .098     -.089      .313      .161      .161     -.241
LIT10P  9          0.000      .247      .295     0.000      .059     -.441      .276     0.000     0.000     0.000
LIT105 10           .044      .188      .323      .020     0.000     -.426      .329      .020      .020     -.030
PRESCO 11          1.000      .748     -.149      .123      .093      .095      .239      .123      .123     -.184
PRESIN 12           .748     1.000     -.199      .029      .262     -.059      .261      .029      .029     -.043
NEWCIR 13          -.149     -.199     1.000     -.069     0.000     -.118      .356     -.069     -.069      .103
RFLMUS 14           .123      .029     -.069     1.000     0.000     -.171     -.194     1.000     1.000      .149
RFLMIX 15           .093      .262     0.000     0.000     1.000     0.000     0.000     0.000     0.000     0.000
RFLMI2 16           .095     -.059     -.118     -.171     0.000     1.000     -.332     -.171     -.171     -.588
RFLMI3 17           .239      .261      .356     -.194     0.000     -.332     1.000     -.194     -.194      .024
RFLCHM 18           .123      .029     -.069     1.000     0.000     -.171     -.194     1.000     1.000      .149
RFLCAM 19           .123      .029     -.069     1.000     0.000     -.171     -.194     1.000     1.000      .149
LINHOM 20          -.184     -.043      .103      .149     0.000     -.588      .024      .149      .149     1.000
LINWHO 21           .013     -.097     -.087      .335     -.761     -.215     -.243      .335      .335      .187
LIBERA 22           .013     -.097     -.087      .335     -.761     -.215     -.243      .335      .335      .187
COLBAF 23           .199     -.056      .134     -.161      .391      .332      .146     -.161     -.161     -.024
INDCRI 24           .250      .058      .245     -.203      .345      .226      .327     -.203     -.203     -.009
IDEDEV 25           .069     -.280      .103      .149     -.226      .256     -.241      .149      .149      .083
IDETRA 26          -.149     -.199     -.048     -.069     0.000     -.118      .356     -.069     -.069     -.463
SECEXN 27           .108      .266     -.210      .068     -.205      .073     -.189      .068      .068     -.008
SECEXT 28           .239      .466     -.134      .161      .195      .155     -.146      .161      .161     -.241
SECEXM 29           .138      .277      .118      .171      .623      .035      .089      .171      .171     -.256
INAANO 30          -.013     -.169      .087      .126      .254      .215     -.054      .126      .126     -.187
INAGEX 31           .048     -.160      .149     -.123     -.280      .138     -.020     -.123     -.123      .184
OMPAQU 32          -.098     -.183      .218     0.000      .261      .325     -.204     0.000     0.000     0.000
ONPADM 33           .095     -.059     -.118      .206     -.519     -.294     -.089      .206      .206      .256
AFTREN 34           .062     -.082     -.112     -.162     -.184      .181     -.457     -.162     -.162      .241
VERPOW 35           .184      .516     -.103     -.149      .226     -.256      .241     -.149     -.149      .222
```

continued

000 0010

```
TOT R   SECTION  3
  VAR            LINWHO      LIBERA      COLRAF      INDCRI      IDEDEV      IDETRA      SFCEXN      SFCEXT      SFCEXM      INAANO
MEANS             1.864       1.864       1.818       2.273       1.182       1.955       2.773       1.727       1.227       1.136
ST.DEV             .351        .351       1.368       1.162        .395        .213       1.307        .456        .429        .351


SIZVLL  1         -.271       -.271       -.020        .078       -.184        .319        .337        .458        .138       -.013
SIZVLM  2         -.417       -.417        .399        .347        .026        .118        .181        .432        .224        .417
POPVLL  3         -.087       -.087        .134        .245       -.463       -.048        .303        .356        .118        .087
POPVLM  4         -.271       -.271       -.020        .250       -.437        .319        .413        .458        .138       -.013
PDEAVM  5          .614        .614       -.351       -.255       -.156       -.087        .344        .054       -.417       -.228
PDFWVM  6          .614        .614       -.351       -.255       -.156       -.087        .344        .054       -.417       -.228
PGRCWH  7         -.106       -.106        .524        .441        .543       -.829       -.090       -.044        .017        .106
FINSTA  8         -.243       -.243       -.083        .057       -.241        .356        .131        .313        .332        .243
LIT10P  9         0.000       0.000       -.138       0.000       -.319       0.000        .145        .138       0.000       -.179
LIT105 10          .026        .026       -.039        .098       -.197        .014        .213        .184       -.035       -.026
PRESCO 11          .013        .013        .199        .250        .069       -.149        .108        .239        .134       -.013
PRESIN 12         -.097       -.097       -.056        .058       -.280       -.199        .266        .466        .277       -.169
NEWCIR 13         -.087       -.087        .134        .245        .103       -.049       -.210       -.134        .118        .087
RFLMUS 14          .335        .335       -.161       -.203        .149       -.069        .068        .161        .171        .126
RFLMIX 15         -.761       -.761        .391        .345       -.226       0.000       -.205        .195        .623        .254
RFLMI2 16         -.215       -.215        .332        .226        .256       -.118        .073        .155        .035        .215
RFLMI3 17         -.243       -.243        .146        .327       -.241        .356       -.189       -.146        .089       -.054
RFLCHM 18          .335        .335       -.161       -.203        .149       -.069        .068        .161        .171        .126
RFLCAM 19          .335        .335       -.161       -.203        .149       -.069        .068        .161        .171        .126
LINHOM 20          .187        .187       -.024       -.009        .083       -.463       -.008       -.241       -.256       -.187
LINWHO 21         1.000       1.000       -.649       -.604        .187       -.087        .344        .054       -.417       -.228
LIBERA 22         1.000       1.000       -.649       -.604        .187       -.087        .344        .054       -.417       -.228
COLRAF 23         -.649       -.649       1.000        .932        .241       -.356       -.211       -.083        .155        .351
INDCRI 24         -.604       -.604        .932       1.000        .094       -.332       -.051        .057        .156        .255
IDEDEV 25          .187        .187        .241        .094       1.000       -.463       -.101       -.241       -.256        .156
IDETRA 26         -.087       -.087       -.356       -.332       -.463       1.000       -.210       -.134        .118        .087
SFCEXN 27          .344        .344       -.211       -.051       -.101       -.210       1.000        .770       -.328       -.033
SFCEXT 28          .054        .054       -.083        .057       -.241       -.134        .770       1.000        .332        .243
SFCEXM 29         -.417       -.417        .155        .156       -.256        .118       -.328        .332       1.000        .417
INAANO 30         -.228       -.228        .351        .255        .156        .087       -.033        .243        .417       1.000
INAGEX 31         -.013       -.013        .239        .094        .690       -.319       -.261       -.453       -.378        .013
OMPAQU 32         -.397       -.397        .408        .240        .236       -.218       -.392       -.404       -.109       -.132
ONPADM 33          .733        .733       -.399       -.443        .256       -.118        .073       -.089       -.224       -.101
AFTREN 34          .170        .170        .314        .179        .573       -.726        .009       -.170       -.331        .017
VERPOW 35         -.187       -.187        .024        .113       -.389       -.103        .378        .505        .256        .187
```

continued

```
TOT R   SECTION  4
  VAR              INAGEX     OMPAQU     ONPADM     AFTREN     VERPOW
MEANS               1.318      1.500      1.773      1.636      1.818
ST.DEV               .477       .512       .429       .727       .395


SIZVLL  1          -.162      -.098      -.370      -.350       .184
SIZVLM  2           .095       .108      -.224      -.333       .256
POPVLL  3          -.319      -.218      -.118      -.112       .463
POPVLM  4          -.371      -.293      -.370      -.625       .437
PDENVM  5          -.013      -.397       .417       .170       .156
PDFNVM  6          -.013      -.397       .417       .170       .156
PGRCWH  7           .528       .375      -.017       .692      -.126
FINSTA  8          -.239      -.204      -.332      -.601       .241
LIT10P  9          -.264      -.123      0.000      0.000       .160
LIT105 10          -.182      -.193       .035       .033       .197
PRESCO 11           .048      -.098       .095       .062       .184
PRESIN 12          -.160      -.183      -.059      -.082       .516
NEWCIR 13           .149       .218      -.118      -.112      -.103
RFLMUS 14          -.123      0.000       .206      -.162      -.149
RFLMIX 15          -.280       .261      -.519      -.184       .226
RFLMI2 16           .138       .325      -.294       .181      -.256
RFLMI3 17          -.020      -.204      -.089      -.457       .241
RFLCHM 18          -.123      0.000       .206      -.162      -.149
RFLCAM 19          -.123      0.000       .206      -.162      -.149
LINFOM 20           .184      0.000       .256       .241       .222
LINWHO 21          -.013      -.397       .733       .170      -.187
LIBERA 22          -.013      -.397       .733       .170      -.187
COLPAF 23           .239       .408      -.399       .314       .024
INDCRI 24           .094       .240      -.443       .179       .113
IDEDEV 25           .690       .236       .256       .573      -.389
IDETRA 26          -.319      -.218      -.118      -.726      -.103
SECEXN 27          -.261      -.392       .073       .009       .378
SECEXT 28          -.458      -.408      -.089      -.170       .505
SECEXM 29          -.370      -.108      -.224      -.333       .256
INAANO 30           .013      -.132      -.101       .017       .187
INAGEX 31          1.000       .293       .139       .487      -.184
OMPAQU 32           .293      1.000      -.542       .256      -.471
ONPADM 33           .138      -.542      1.000       .181       .026
AFTREN 34           .487       .256       .181      1.000      -.241
VERPOW 35          -.184      -.471       .026      -.241      1.000

   .                         .                      .
   .                         .                      .
   .                         .                      .
```

continued

```
F RATIOS FOR FOR INDIVIDUAL VARIABLES

NUMBER OF DEGREES OF FREEDOM ARE   2  AND    19

AMONG MEAN SQR    WITHIN MEAN SQR    F RATIO    VARIABLE
      .003              .251            .01        1  SIZVLL
      .048              .198            .24        2  SIZVLM
      .027              .047            .58        3  POPVLL
      .470              .202           2.33        4  POPVLM
      .245              .111           2.22        5  PDENVM
      .245              .111           2.22        6  PDEMVM
      .382              .795            .48        7  PGROWH
      .315              .196           1.60        8  FINSTA
      .533              .575            .93        9  LIT10P
      .927              .479           1.94       10  LIT105
      .603              .188           3.21       11  PRESCO
      .594              .225           2.64       12  PRESIN
      .027              .047            .58       13  NEWCIR
      .076              .088            .86       14  RFLMUS
      .867             1.172            .74       15  RFLMIX
      .382              .163           2.34       16  RFLMI2
      .215              .207           1.04       17  RFLMI3
      .303              .351            .86       18  RFLCHM
      .303              .351            .86       19  RFLCAM
      .103              .161            .64       20  LINHOM
      .079              .128            .62       21  LINWHO
      .079              .128            .62       22  LIBERA
      .436             2.021            .22       23  COLHAF
      .715             1.418            .50       24  INDCAT
      .003              .172            .02       25  IDEDEV
      .061              .044           1.38       26  IDETRA
     5.848             1.272           4.60       27  SECEXN
      .315              .196           1.60       28  SECEXT
      .315              .170           1.85       29  SECEXM
      .012              .135            .09       30  INAANO
      .103              .240            .43       31  INAGEX
      .133              .275            .48       32  OMPAQU
      .048              .198            .24       33  ONPADM
      .212              .561            .38       34  AFTREN
      .170              .154           1.10       35  VERPOW


VARIABLE  RAOS V    V ADDED      SIGNIFICANCE OF
ENTERED  FOR TOTAL  BY VAR.  TOTAL SET  ENTERED VARIABLE
            SET     ENTERED             AS ADDED  ALONE
27 SECEXN     9.20       9.20  1.1000E-01 1.10E-01 8.90E-01
11 PRESCO    17.03       7.83  1.1000E-01 1.10E-01 8.90E-01
10 LIT105    22.57       5.54  1.1000E-01 1.10E-01 8.90E-01
12 PRESIN    26.68       4.11  1.1000E-01 1.10E-01 8.90E-01
 4 POPVLM    30.52       3.84  1.1000E-01 1.10E-01 8.90E-01
29 SECEXM    34.59       4.07  1.1000E-01 1.10E-01 8.90E-01
16 RELMI2    38.24       3.65  1.1000E-01 1.10E-01 8.90E-01
14 RFLMUS    40.93       2.69  1.1000E-01 1.10E-01 8.90E-01
35 VERPOW    43.17       2.23  1.1000E-01 1.10E-01 8.90E-01
20 LINHOM    44.42       1.25  1.1000E-01 1.10E-01 8.90E-01

VARIABLES ENTERED TC HERE WILL BE USED FOR ANALYSIS
24 INDCBI    45.24        .82  1.1000E-01 1.10E-01 8.90E-01
```

continued

```
DISCRIMINANT FUNCTICNS AS COLUMNS

TRACE OF W-INVERSE*A =          6.63170

VECTOR   SECTION  1
ROOTS            5.830        .802
PERCNT          87.905      12.095


SIZVLL  1        0.000       0.000
SIZVLM  2        0.000       0.000
POPVLL  3        0.000       0.000
POPVLM  4         .205        .488
PDENVM  5        0.000       0.000
PDEWVM  6        0.000       0.000
PGRCWH  7        0.000       0.000
FINSTA  8        0.000       0.000
LIT10P  9        0.000       0.000
LIT105 10         .267       -.033
PRESCO 11         .022        .296
PRESIN 12        -.679       -.269
NEWCIR 13        0.000       0.000
RFLMUS 14        -.458        .232
RFLMIX 15        0.000       0.000
RFLMI2 16         .059       -.589
RFLMI3 17        0.000       0.000
RFLCHM 18        0.000       0.000
RFLCAM 19        0.000       0.000
LINHOW 20         .401       -.096
LINWHO 21        0.000       0.000
LIBERA 22        0.000       0.000
COLRAF 23        0.000       0.000
INDCRI 24        0.000       0.000
IDEDEV 25        0.000       0.000
IDETRA 26        0.000       0.000
SFCEXN 27         .172       -.170
SFCEXT 28        0.000       0.000
SFCEXM 29         .011       -.120
INAANO 30        0.000       0.000
INAGEX 31        0.000       0.000
OMPAQU 32        0.000       0.000
ONPADM 33        0.000       0.000
AFTREN 34        0.000       0.000
VERPOW 35         .149       -.384
```

continued

```
SCALED VECTORS

VECTOR  SECTION  1
ROOTS            5.830       .802
PERCNT          87.905     12.095


SIZVLL  1        0.000      0.000
SIZVLM  2        0.000      0.000
POPVLL  3        0.000      0.000
POPVLM  4         .401       .955
PDENVM  5        0.000      0.000
PDEMVM  6        0.000      0.000
PGROWH  7        0.000      0.000
FINSTA  8        0.000      0.000
LIT10P  9        0.000      0.000
LIT105 10         .806     -.100
PRESCO 11         .041       .559
PRESIN 12       -1.402     -.556
NEWCIR 13        0.000      0.000
RFLMUS 14        -.591       .299
RFLMIX 15        0.000      0.000
RFLMI2 16         .104    -1.037
RFLMI3 17        0.000      0.000
RFLCHM 18        0.000      0.000
RFLCAM 19        0.000      0.000
LINHOM 20         .702     -.168
LINWHO 21        0.000      0.000
LIBERA 22        0.000      0.000
COLRAF 23        0.000      0.000
INDCRI 24        0.000      0.000
IDEDEV 25        0.000      0.000
IDETRA 26        0.000      0.000
SECEXN 27         .845     -.835
SECEXT 28        0.000      0.000
SECEXM 29         .019     -.215
INAANO 30        0.000      0.000
INAGEX 31        0.000      0.000
OMPAQU 32        0.000      0.000
ONPADM 33        0.000      0.000
AFTREN 34        0.000      0.000
VERROW 35         .255     -.658



LAMBDA FOR TEST OF H2 =       .0812504

DF1=     20.0000000

DF2=     20.0000000

FOR TEST OF H2, F =      2.5082225
```

continued

130

```
PERCENT OF TRACE= 100.000 USING   2 DISCRIMINANT FUNCTIONS.

CENTROIDS AND DISPERSIONS IN REDUCED SPACE

NO. OF GROUPS =  3

NO. OF TEST VARIABLES = 35

NO. OF LINEAR COMBINATIONS =  2

CENTROIDS OF GROUPS IN REDUCED SPACE, ROW-WISE

GROUP  1       -.0809271      -1.0867351

GROUP  2        .4676876      -1.6055551

GROUP  3        .9263286       -.5761172

DISPERSION IN REDUCED SPACE FOR GROUP  1
       .0201177       -.0032946
      -.0032946        .1432824
        2.8716549E-03

DISPERSION IN REDUCED SPACE FOR GROUP  2
       .0705991       -.0004544
      -.0004544        .0533200
        3.7641375E-03

DISPERSION IN REDUCED SPACE FOR GROUP  3
       .0280889        .0063847
       .0063847        .0417934
        1.1331660E-03

CHI SQUARES AND GROUP MEMBERSHIP PROBABILITIES FOR GROUP  1 CENTROID
2         1            0.0000           9.2433          36.4669
3         1             .9949            .0051            .0000

CHI SQUARES AND GROUP MEMBERSHIP PROBABILITIES FOR GROUP  2 CENTROID
2         1           16.2500           0.0000          14.3258
3         1             .0006            .9980            .0014

CHI SQUARES AND GROUP MEMBERSHIP PROBABILITIES FOR GROUP  3 CENTROID
2         1           50.9635          10.4803           0.0000
3         1             .0000            .0029            .9971
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 18.513 seconds for central-processor time and 139.407 seconds for peripheral-processor time with a memory useage of 111,600 words. Chargeable computer time was $7.33.

Charge to user = computer time + postage and handling + network overhead
= $7.33 + $15.00 + network overhead
= $22.33 + network overhead

CONTENTS—EIDISC

pages

1,2 Identification & Abstract
3–6 User Instructions
7–26 I/O
27 Cost—Contents

DESCRIPTIVE TITLE	Multiple Regression and Correlation Analysis, Modified with Plots
CALLING NAME	PLOTYY NUCC079
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

This program calculates basically the same information as does BMD29 (EIN No. 000 0012). However, it also plots the predicted Y versus observed Y values of the dependent variable.

As in BMD29, the independent variables are listed in the order of their importance, based on the reduction of sums of squares of the dependent variable attributable successively to each independent variable. The maximum number of variables that can be processed by this program is 59.

USER INSTRUCTIONS

Program input cards are exactly the same as those for BMD29 (EIN No. 000 0012), except that

(1) a blank card or a PLOT card must follow each R–D card in the input stack

(2) a blank card causes an exit from the plotting sequence, and a PLOT card causes the plot to be executed

(3) the user must select the plot range that he wishes

Example: If a person wants to consider people in a grade-point continuum who have grade-point averages from 1.5 to 4.0, he would punch the card

```
PLOT      4.000      1.500
```

Columns	
1– 4	PLOT
5–14	Highest value of predicted or observed Y to be plotted
15–24	Lowest value of predicted or observed Y to be plotted

These cards must follow the R–D cards to which they refer.

The user must also select option 02 on the R–D card to generate a scratch tape with plot points on it. If this is not done, the tape will have on it the value of the last plot executed or the value of whatever had been written on the tape during a job that had used the tape earlier.

Job Deck Structure

```
Job card
LIBRARY (PLOTYY)
LGO.
7–8–9   (EOR card)
    Program control cards and data (see BMD29 writeup)
6–7–8–9 (EOI card)
```

REFERENCE

See Catalog entry for BMD29 (EIN No. 000 0012) for further instructions for usage.

SAMPLE INPUT

```
VLORR,CH[redacted].CU72100.    PLOTYY
LIBRARY(PLOTYY)
LGO.
PRONE 04000090000000700.00
TRACTORROFINCASHREGRP
-00003
 57203     6-     4    344
-92728    13     10    217
  8713-    2-     8    236
  8966    35     36     17
 12034-    4      1    382
-83962     4      5    199
 14635    17      9    156
 15561    12     16    367
  2221     3      3    296
R00201020203
PLOT 57.0      -92.0

                 .
                 .
                 .
PRGWYN 4   150000  1 0.01
NO.PRSCOMSLSTRASLSAVPGRT

 +2109-   82+     0-    49
 +1860+  614+     0+    96
 +1728+  524+     0+    42
  +808+  298+     0+     1
 +1061+  182+     8+    35
 +2039+  214+    27+    31
 +2441+    9+    34+    11
 -1287-   92+    42-     6
 +5251+  354+   105+    30
 +2741+  152+    79+    47
  -277+  325+     3+    46
   -74+  288-     5+    61
  -861+  199+     9+    60
 -2833+  207+    26+    70
 +1114+  235+    56+    41
R00201 0
PLOT 5251.0     -2833.0
FINISH
```

00

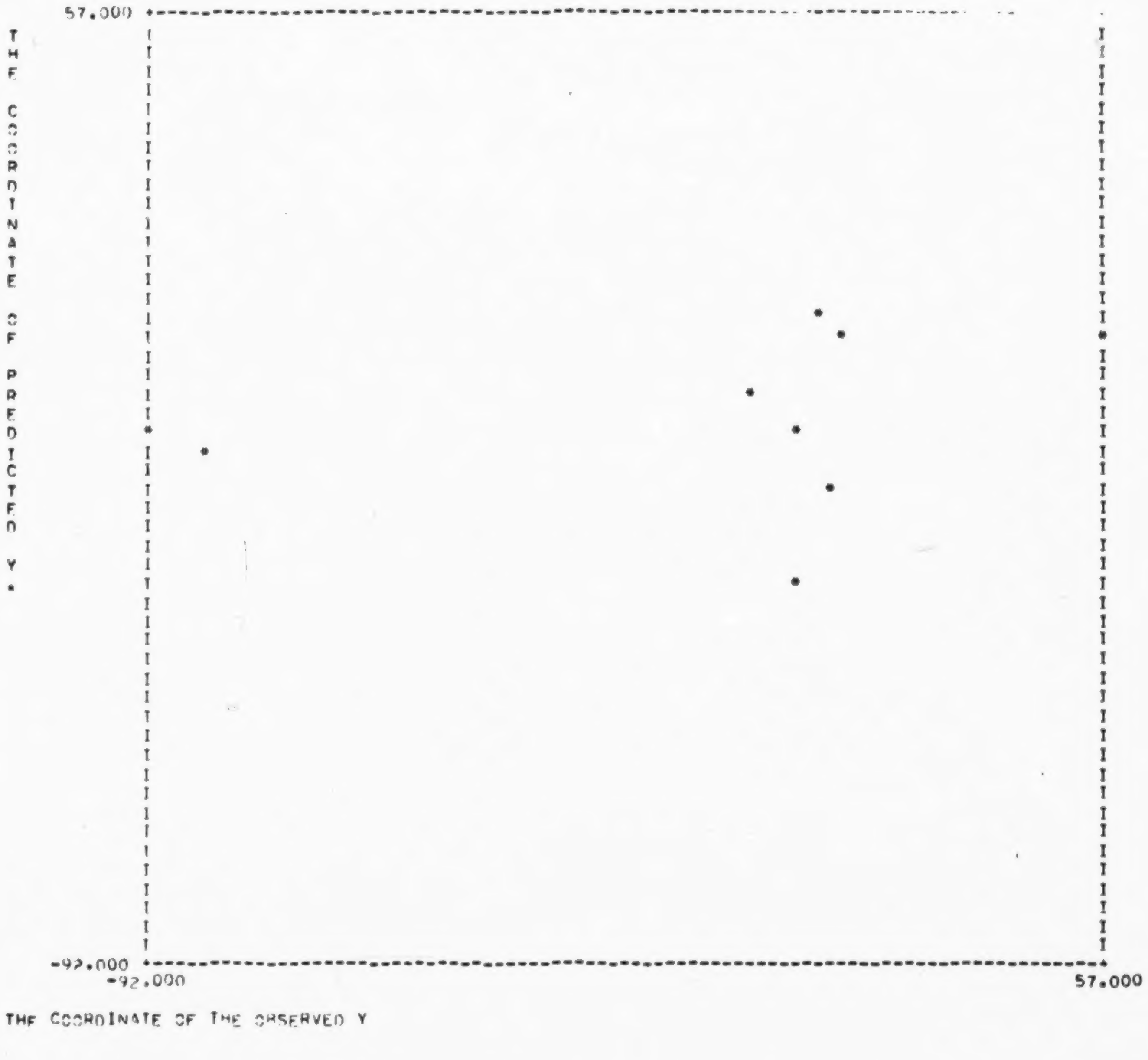
SAMPLE OUTPUT

```
MULTIPLE REGRESSION AND CORRELATION ANALYSIS NO. 3
BIMD 29 - UCLA MEDICAL CENTER

PROBLEM NUMBER  ONE

NO. OF VARIABLES    4
SAMPLE SIZE         9


SUMS
          -57.37700             84.00000             62.00000           2208.00000


SUMS OF SQUARES
        19686.02498           1908.00000           1692.00000         650060.00000


CROSS PRODUCT SUMS

ROW   1
        19686.02498           -507.73600          -1016.90800          -1712.84700
ROW   2
          -507.73600          1908.00000           1680.00000          12202.00000
ROW   3
         -1016.90800          1680.00000           1692.00000           6839.00000
ROW   4
         -1712.84700         12202.00000           6839.00000         650060.00000


CROSS PRODUCTS OF DEVIATIONS

ROW   1
        19320.23386             27.78267           -621.64422          12363.64367
ROW   2
           27.78267           1124.00000           1101.33333          -8406.00000
ROW   3
         -621.64422           1101.33333           1264.88889          -8371.66667
ROW   4
        12363.64367          -8406.00000          -8371.66667         108364.00000


SIMPLE CORRELATION COEFFICIENTS

ROW   1
  1.00000    .00596   -.12575    .27021

ROW   2
   .00596   1.00000    .92365   -.76166

ROW   3
  -.12575    .92365   1.00000   -.71506

ROW   4
   .27021   -.76166   -.71506   1.00000

PROBLEM NUMBER  ONE
REPLACEMENT AND DELETION    1

DEPENDENT VARIABLE IS NOW     1
NUMBER OF VARIABLES DELETED   2
VARIABLES DELETED...  2  3
```

continued

```
                  ANALYSIS OF VARIANCE FOR REGRESSION

      SOURCE OF VARIATION         D.F.        SUM OF          MEAN           F
                                              SQUARES        SQUARES        VALUE
DUE TO REGRESSION............       1       1410.61316     1410.61316      .55134
DEVIATION ABOUT REGRESSION...       7      17909.62070     2558.51724
                     TOTAL...       8      19320.23386


                  INTERCEPT (A VALUE) IS      -34.36620

  VARIABLE            MEAN          STANDARD          REG.        STD. ERROR       COMPUTED       PARTIAL
NO.    NAME                        DEVIATION          COEF.     OF REG.COEF.       T VALUE      CORR. COEF.
 4     GNP         245.33333       116.38514         .11409         .15366          .74252         .27021
DEPENDENT
 1     TRACTO       -6.37522        49.14295

COMPARE CHECK ON FINAL COEFFICIENT......              .11409


       INCREMENTS FOR INDEPENDENT VARIABLES          *                         CUMULATIVE     REGRESSIONS
                                                     *
  VARIABLE              SUMS OF      PROP.     F VALUE  *    STD. ERROR        SUMS OF      PROP.VAR.        F        MULTIPLE
NO.    NAME             SQUARES      VAR.     EACH TERM *   OF ESTIMATE        SQUARES      = R SQ.        VALUE         R
 4     GNP            1410.61316    .07301      .55134        50.58179       1410.61316     .07301       .55134       .27021

PROPORTION OF VARIANCE SPE-
  CIFIED TO LIMIT VARIABLES     0.00000


                  TABLE OF RESIDUAL

OBSERVATION       Y VALUE            Y ESTIMATE          RESIDUAL
     1            57.20300             4.88202           52.32098
     2           -92.72800            -9.60788          -83.12012
     3             8.71300            -7.44010           16.15310
     4             8.96600           -32.42660           41.39260
     5            12.03400             9.21758            2.81642
     6           -83.98200           -11.66156          -72.32044
     7            14.63500           -16.56759           31.20259
     8            15.56100             7.50617            8.05483
     9             2.22100            -1.27904            3.50004


 VON NEUMANN RATIO IS     2.96764
DURBIN-WATSON COEFFICIENT                      2.6379


RATIO OF RANGES FOR THE SMALLEST RESIDUAL.....          .087
RATIO OF RANGES FOR THE LARGEST RESIDUAL......          .088

CRITICAL VALUE OF THE RATIO AT ALPHA = .10 ...          .441
```

continued


57.000
-92.000
-92.000
57.000
THE COORDINATE OF PREDICTED Y
THE COORDINATE OF THE OBSERVED Y

⋮ ⋮ ⋮

continued

```
MULTIPLE REGRESSION AND CORRELATION ANALYSIS NO. 3
BIMD 29 - UCLA MEDICAL CENTER

PROBLEM NUMBER  GWYN

NO. OF VARIABLES    4
SAMPLE SIZE        15


SUMS
        15820.00000          3427.00000           384.00000           519.00000


SUMS OF SQUARES
     69620914.00000       1304229.00000         24906.00000         34923.00000


CROSS PRODUCT SUMS

ROW    1
     69620914.00000       4553348.00000        840891.00000        352662.00000

ROW    2
      4553348.00000       1304229.00000         72722.00000        185658.00000

ROW    3
       840891.00000         72722.00000         24906.00000         12703.00000

ROW    4
       352662.00000        185658.00000         12703.00000         34923.00000


CROSS PRODUCTS OF DEVIATIONS

ROW    1
     52936087.33333        939005.33333        435899.00000       -194710.00000

ROW    2
       939005.33333        526273.73333        -15009.20000         67083.80000

ROW    3
       435899.00000        -15009.20000         15075.60000          -583.40000

ROW    4
      -194710.00000         67083.80000          -583.40000         16965.60000


SIMPLE CORRELATION COEFFICIENTS

ROW    1
  1.00000    .17790    .48795   -.20546

ROW    2
   .17790   1.00000   -.16851    .70995

ROW    3
   .48795   -.16851   1.00000   -.03648

ROW    4
  -.20546    .70995   -.03648   1.00000

PROBLEM NUMBER  GWYN
REPLACEMENT AND DELETION    1

DEPENDENT VARIABLE IS NOW      1
NUMBER OF VARIABLES DELETED    0
```

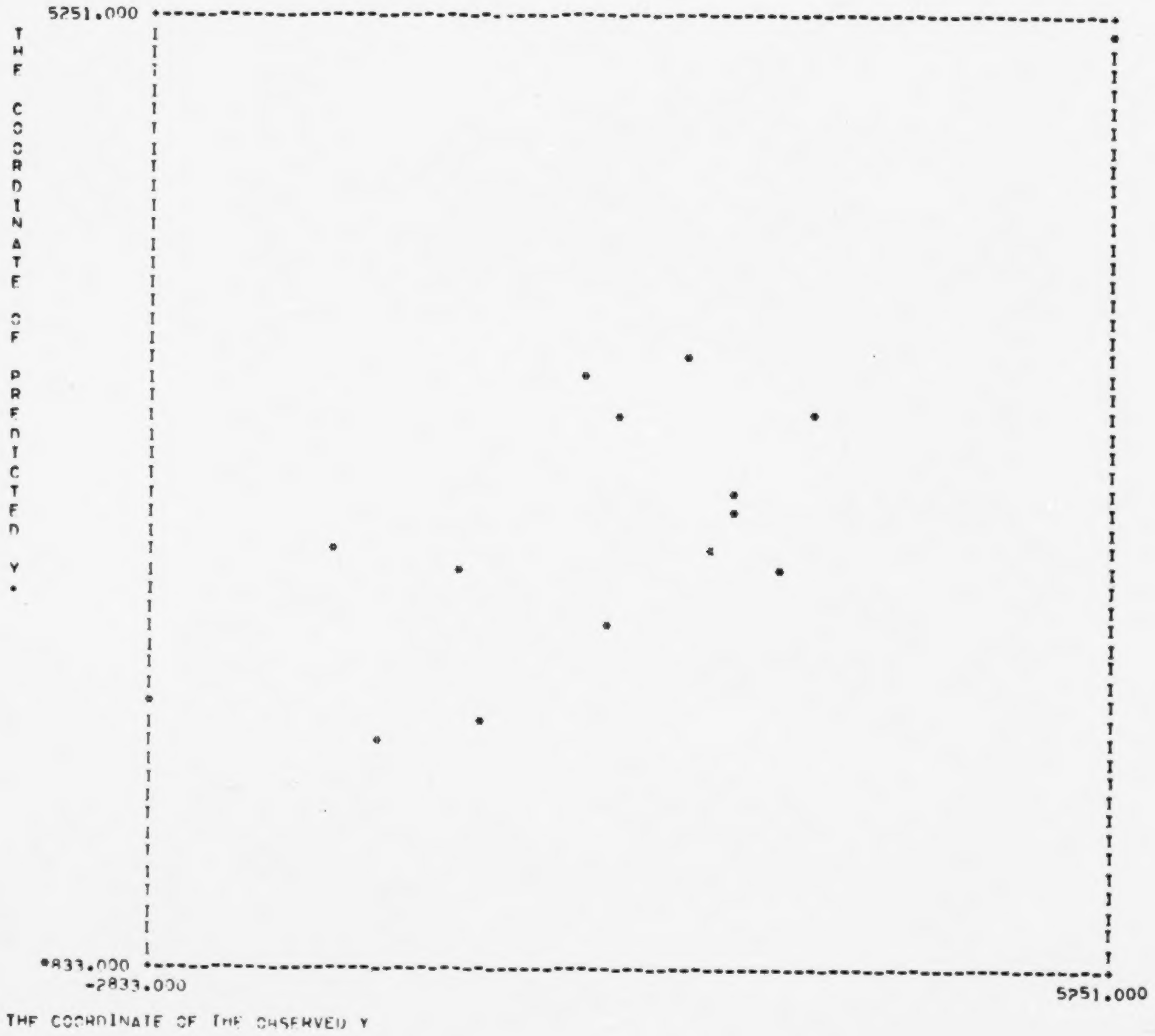
continued

```
                ANALYSIS OF VARIANCE FOR REGRESSION

      SOURCE OF VARIATION        D.F.      SUM OF        MEAN          F
                                           SQUARES       SQUARES       VALUE
DUE TO REGRESSION.............    3  31606442.8158210535480.93861    5.43330
DEVIATION ABOUT REGRESSION...    11  21329644.51751 1939058.59250
                      TOTAL...   14  52936087,33333


               INTERCEPT (A VALUE) IS    -257.34574

  VARIABLE         MEAN        STANDARD       REG.       STD. ERROR     COMPUTED     PARTIAL
NO.   NAME                     DEVIATION      COEF.     OF REG.COEF.    T VALUE     CORR. COEF.
 3    TRASLS     25.60000      32.81507     35.48895     11.58914      3.06226       .67837
 2    COMSLS    228.46667     193.88394      8.27418      2.78333      2.97276       .66745
 4    AVPGRT     34.60000      34.81133    -42.97338     15.29045     -2.81047      -.64649
DEPENDENT
 1    NO.PGS   1054.66667    1944.51770

COMPARE CHECK ON FINAL COEFFICIENT......    -42.97338


       INCREMENTS FOR INDEPENDENT VARIABLES        *                       CUMULATIVE    REGRESSIONS
                                                   *
  VARIABLE           SUMS OF       PROP.   F VALUE *    STD. ERROR       SUMS OF       PROP.VAR.       F        MULTIPLE
NO.   NAME           SQUARES       VAR.   EACH TERM *  OF ESTIMATE       SQUARES       = R SQ.      VALUE        R
 3    TRASLS  12603673.36630     .23809    4.06243    1761.38962   12603673.36630     .23809     4.06243     .48795
 2    COMSLS   3686628.75745     .06964    1.20722    1747.51693   16290302.12375     .30774     2.66720     .55474
 4    AVPGRT  15316140.69207     .28933    7.89875    1392.50084   31606442.81582     .59707     5.43330     .77270

PROPORTION OF VARIANCE SPE-
  CIFIED TO LIMIT VARIABLES     .01000
```

continued

```
                         TABLE OF RESIDUAL

OBSERVATION       Y VALUE            Y ESTIMATE           RESIDUAL
     1           2109.00000          1126.89380           982.10620
     2           1860.00000           697.55633          1162.44367
     3           1728.00000          2273.44272          -545.44272
     4            808.00000          2165.38662         -1357.38662
     5           1061.00000            28.39828          1032.60172
     6           2039.00000          1139.35556           899.64444
     7           2441.00000           551.03885          1889.96115
     8          -1287.00000           729.80569         -2016.80569
     9           5251.00000          5108.85199           142.14801
    10           2741.00000          1784.20746           956.79254
    11           -277.00000           561.45414          -838.45414
    12            -74.00000          -673.20283           599.20283
    13           -861.00000          -869.78626             8.78626
    14          -2833.00000          -630.01455         -2202.98545
    15           1114.00000          1826.61220          -712.61220


 VON NEUMANN RATIO IS     2.19303
DURBIN-WATSON COEFFICIENT                  2.0468


RATIO OF RANGES FOR THE SMALLEST RESIDUAL.....       .261
RATIO OF RANGES FOR THE LARGEST RESIDUAL......       .264

CRITICAL VALUE OF THE RATIO AT ALPHA = .10 ...       .472
```

continued


5251.000
THE COORDINATE OF PREDICTED Y.
*833.000
-2833.000
5251.000
THE COORDINATE OF THE OBSERVED Y

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 3.395 seconds for central-processor time and 40.673 seconds for peripheral-processor time with a memory useage of 72,100 words. Chargeable computer time was $1.64.

Charge to user = computer time + postage and handling + network overhead
= $1.64 + $15.00 + network overhead
= $16.64 + network overhead

CONTENTS—PLOTYY

pages	
1	Identification & Abstract
3	User Instructions
5–12	I/O
13	Cost—Contents

20

DESCRIPTIVE TITLE	Multiple Regression and Correlation Analysis
CALLING NAME	BMD29 NUCC043
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Program originated at UCLA Medical Center as part of the Biomedical Statistics Package
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

This program is a modification and extension of BMD06 of the UCLA biomedical package. The primary modification is that the independent variables are listed in the order of their importance, based on the reduction of sum of squares of the dependent variable attributable successively to each independent variable. Additional output includes cumulative

(1) standard errors of estimate,
(2) sums of squares,
(3) proportions of variance,
(4) F values,
(5) multiple correlation coefficients.

The maximum number of variables that can be processed by this pro- is 59.

The upper limitation on sample size is 99,999 and the lower limitation on sample size is two greater than the number of variables.

continued

144

This program can perform a different transformation of any variable and generate new variables if desired, according to the codes specified in the transgeneration cards or through lagging. Any number of variables can be generated, but the total number of variables must not exceed 59.

Any variable, original or generated, can be named the dependent variable. There is no limit to the number of *replacements* (see Replacement—Deletion Cards).

The maximum number of variables that can be deleted at one time is 32. However, there is no limit to the number of deletions of different sets of variables.

The standard format (12F6.0) for input data or a variable format may be used.

This program uses a reduction of the sum-of-the-squares method to calculate regression and correlation coefficients to fit data points.

REFERENCES

Although no specific references are provided, the user is directed to check statistical references for the Von Neuman ratio and the Durbin—Watson coefficient of correlation.

USER INSTRUCTIONS

Description of Input Data

Control Cards

1. *Problem Card* (one problem card for each problem)

Columns	*Description*
1–2	PR
3–6	Problem number (may be alphabetical characters)
7–8	Number of original variables, p ($p \leq 59$)
9–13	Sample size, n
14–15	=00 if no transgeneration =m the number of transgeneration cards ($m \leq 99$)
16–17	=00 No variables added to original set after transgeneration and lags =N N=q+r. If q equals the number of variables added to the original set after transgeneration (see transgeneration cards) and r equals the number of variables added to the original set after lagging, then the number punched in Cols. 16–17 is q+r
18–20	Number of replacement– deletion cards
21–25	Percent of sum of squares to limit variables entering in a regression model. Keypunch a value with a decimal point. The choice of percentage value for the limiting variable will depend upon the purpose of the analysis. A suggested trial value is 1% (0.01). If *all* independent variables are to be included in a regression model, keypunch 0.0
26–27	=00 or blank (no lags desired) =L number of variables lagged
71–72	=00 no variable-format cards [standard input data in (12F6.0) format] =k number of variable-format cards ($k \leq 5$)

continued

2. *Lag Cards*

Columns	*Description*
1–2	LG
3–4	Variable number to be assigned to this variable after lag takes place
5–6	Lag factor. Number of periods to be lagged (≤ 50)
7–8	Old variable number being lagged

3. *Transgeneration Card(s)*

The number of transgeneration cards is indicated in Cols. 14–15 of the problem card. The same number of transgeneration cards must appear in the deck as indicated in Cols. 14–15 of the problem card. Different types of transformations can be performed successively on the same variable, if desired. Any operation that is performed on one observation of a given variable is performed on all other observations of a variable. By using these options, the user can do polynomial fitting and can also do other operations that may become necessary from time to time. Variables are numbered sequentially, left to right, both original and generated.

Columns	*Description*
1–2	TR
3–4	Variable number to be assigned to this variable after the operation has taken place. If the original data are not to be used, merely reassign the original variable number to this location
5–6	Transgeneration code. See List of Codes and their restrictions
7–8	Number of variable being transformed
9–14	The identifying number of the second variable entering into the transgeneration option, *OR*, the constant needed, right-adjusted

4. *Variable-Name Card(s)*

The purpose of Variable-Name Card(s) is to identify the var-

continued

iables in the output by their names for your convenience. ALL VARIABLES ARE TO BE NAMED, BOTH ORIGINAL AND GENERATED

Columns	*Description*
1–6	Name of 1st variable
7–12	Name of 2nd variable
13–18	Name of 3rd variable
.	
.	
67–72	Name of 12th variable

If there are more than 12 variables, continue keypunching on the second card in the same manner.

If variables are to be generated, the names of these variables must also be keypunched in addition to those of the original variables. *The number of cards required is* (p+q+r)/12, *rounded up to the nearest integer,* i.e., one card for every 12 variables.

If the identification of the variables by their names is not desired, use blank card(s) [(p+q+r)/12] for this purpose. Variable-name card(s) *must be present.*

5. *Standard-Scale Card(s)*

Since the BMD29 program assumes all input data to be whole numbers (unless a decimal is punched), it may be necessary to scale input data in order not to lose significant digits or to place the decimal point. This is the purpose of the scale factors. All punched input data are multiplied by 10 to the power equal to the proper scale factor.

Columns	*Description*
1–6	The power of 10 that the first variable is multiplied by
7–12	The power of 10 that the second variable is multiplied by
13–18	The power of 10 that the third variable is multiplied by
⋮	

continued

67–72 The power of 10 that the twelfth variable is multiplied by

If there are more than 12 original variables to be scaled, continue onto successive cards. SCALING IS DONE ONLY ON ORIGINAL VARIABLES. *If you do not have any scaling factors, be sure you put blank cards in the deck for the standard scale cards.* Total number of cards required is the integer part of (P/12)+1, i.e., one card for every 12 *original* variables.

6. *Standard or Variable-Format Card(s)*

The standard input data for the BMD29 program is 12F6.0. If your data are to be read by *another* format, then you need a variable-format card(s). If a nonzero number is specified in Cols. 71–72 of the problem card, the same number of variable-format card(s) must be prepared. In preparing the variable-format card, the word "format" is not used. The desired format expression is enclosed in parentheses and begins in the first column. An example follows.

(12F3.0, F4.0, 11F2.0)

Only Cols. 1–72 of the variable-format card(s) can be used. If the variable format cannot be completed in Cols. 1–72, continue in Col. 1 of the next card, etc.

7. *Replacement and Deletion Card(s)*

The R–D card, has a fourfold purpose:

(1) to indicate the replacement of the dependent variable;
(2) to indicate the deletion of variables;
(3) to indicate a replacement and deletion; and
(4) to control the output.

The replacement of a dependent variable and deletion of different sets of variables may be made as many times as desired. This means that it is possible to make multiple regression and correlation analyses with selected sets of variables. The program will retain all the variables, original and generated, until all R–D cards for one problem are processed.

For multiple regression and correlation, R–D card(s) *must* be present, and the number of R–D card(s) prepared *must* agree with the number specified in Cols. 18–20 of the problem card.

continued

If no multiple regression and correlation are desired, no R–D card(s) are necessary.

Columns	*Description*
1–2	RD
3–4	=02 if the table of residuals and analysis of extreme residuals are desired. If sample size is large, 02 punch is not recommended =01 if only the analysis of extreme residuals is desired =00 if neither one is desired
5–6	A variable to be treated as the next dependent variable
7–8	Total number of variables to be deleted ≤ 32
9–10	Number of first variable to be deleted
11–12	Number of second variable to be deleted
⋮	
71–72	Number of 32nd variable to be deleted

The maximum number of variables that can be deleted at one time is 32. The variables to be deleted must be punched in ascending numeric order; e.g., if variable 2 and variable 7 are to be deleted, 2 must be punched before 7.

8. *Finish Card*

1–6	FINISH

Description of Output

If lagged variables are used, these are listed first with the variables lagged, periods lagged and the original variables given, and a revised sample size due to lagging. If transgeneration is to occur, the transgeneration cards are listed with the assigned variable, type of transformation, variable transformed, and second variable or constant. A simple correlation matrix is then listed showing correlation between each variable.

The additional output includes standard errors of the estimate, sums of squares, proportions of variance, F values, multiple correlation coefficients, t values, and multiple R values.

continued

Additional output such as Von Neuman ratio, residuals, and Durbin-Watson ratio are also calculated.

Limitations

Maximum number of variables	59
Maximum sample size	99999
Minimum sample size—two greater than number of variables	
Maximum number of deletions	32
Maximum number of transgeneration cards	99
Maximum number of variables lagged	50
Maximum number of variable format cards	5
Maximum number of periods to be lagged	50

Additional Information

Codes for Transgeneration Cards

Code	*Transformation*	*Restriction*
01	$x' = \sqrt{x}$	$x \geq 0$
02	$x' = \sqrt{x} + (x+1)^{\frac{1}{2}}$	$x \geq 0$
03	$x' = \log_{10} x$	$x > 0$
04	$x' = e^{x}$	$x \neq 0$
05	$x' = \sin^{-1}\sqrt{x}$	$0 \leq x \leq 1$
06	$x' = \sin^{-1}[x/(n+1)]^{\frac{1}{2}} + \sin^{-1}[(x+1)/(n+1)]^{\frac{1}{2}}$	$0 \leq x/n \leq 1$
07	$x' = 1/x$	$x \neq 0$
08	$x' = x+c$	—
09	$x' = x*c$	—
10	$x' = x^{c}$	$x > 0$
11	$x' = x_a + x_b$	—
12	$x' = x_a - x_b$	—
13	$x' = x_a * x_b$	—
14	$x' = x_a / x_b$	$x_b \neq 0$

Example: TO TAKE LOG OF VARIABLE 1 and place in variable 6 slot:

Beginning in column 1: TR060301 (That is all)

continued

TO TAKE LOG OF VARIABLE 1 and place back in variable 1 slot:

```
TR010301
```

TO TRANSFORM 1, 2, 3, 4,

```
TR010301
TR010302
TR010303
TR010304
```

Remember, if you are placing variables in another slot, you must punch any additional variable as an addition in the problem card.

Lagging Variables

This option allows you to lag up to 50 variables for up to 50 periods. *All lagging is done prior to transgeneration.* To use this option, three areas of data input are affected. First, on the problem card in Cols. 16 and 17, the number of variables added to the original set must include those added by transgeneration *and* by lagging. Second, on the problem card in Cols. 26 and 27, the number of variables to be lagged (the number of lag cards to follow) must be included. If no lags are desired, a 00 or blank will be sufficient. Third, lag cards are necessary (the number of lag cards must be equal to the number in Cols. 26 and 27 of the problem card). A typical lag card would be

```
LG050101
```

1. LG stands for lag
2. 05= Variable number to be assigned to this variable after lag takes place
3. 01= Number of periods to be lagged
4. 01= Original variable being lagged

Included in the output will be a Table, as shown below.

Lagged variable	*Periods lagged*	*Original variable*
4	1	1
5	3	1
6	5	2
7	4	3
8	2	2

Only original variables may be lagged. For example,

```
LG050301
LG060105, is not permitted.
```

continued

To accomplish this, the following card setup must be used.

LG050301
LG060401

You may lag a variable back into the same location. For example,

LG010201
LG020101

will give the desired results of lagging variable 1 by 1 period and storing the results in variable 2 after the first card lags variable 1 into itself.

Original variable 1	*New variable 1*	*New variable 2*
1.1		
2.3		1.1
4.8	1.1	2.3
3.5	2.3	4.8
7.6	4.8	3.5
9.4	3.5	7.6
8.7	7.6	9.4
7.1	9.4	8.7
5.8	8.7	7.1
.	.	.
.	.	.
.	.	.

The original sample size is reduced by the maximum number of periods to be lagged to create the effective sample size. This effective sample size is used in *all* subproblems.

Job Deck Structure

(System cards)

Job card
LIBRARY (BMD29)
LGO.
7–8–9 EOR

(Program control cards)

(a) Problem card for the first problem (required)
(b) Lag card (optional)
(c) Transgeneration card(s) (optional)
(d) Variable-name card(s) (required)
(e) Scale card(s) (required)
(f) Variable-format card(s) (optional)
Data

continued

(g) Replacement-deletion card(s) (required if multiple regression and correlation are desired)

(h) Finish card

More than one problem can be processed consecutively. Cards (a)-(g) may be repeated as many times as desired. The *last* card of the *last* problem must be a finish card.

6-7-8-9 EOI

SAMPLE INPUT

```
VLOBR.CH[redacted].CM37300.   BMD29
LIBRARY(BMD29)
LGO.
PR0007030001100000300.00


(F4.0,F6.0,F5.0)
1440153700007921
1360148400007581
1241143300007225
1238138300007368
1055133400006668
1028128300006143
0979123400005792
0906118400005377
0825113400005000
0785108400004580
0720103400004287
RD02010102
RD02010103
RD0201
FINISH
```

1

SAMPLE OUTPUT

```
MULTIPLE REGRESSION AND CORRELATION ANALYSIS NO. 3
BIMD 29 - UCLA MEDICAL CENTER

PROBLEM NUMBER  0007

NO. OF VARIABLES   3
SAMPLE SIZE       11


SUMS
        11577.00000        1412400.00000          67942.00000


SUMS OF SQUARES
     12760261.00000  184112280000.00000      435714686.00000


CROSS PRODUCT SUMS

ROW   1
     12760261.00000    1526008100.00000       74502823.00000

ROW   2
   1526008100.00000  184112280000.00000     8932590500.00000

ROW   3
     74502823.00000     8932590500.00000      435714686.00000


CROSS PRODUCTS OF DEVIATIONS

ROW   1
       575994.72727       39521300.00000        2996956.27273

ROW   2
     39521300.00000     2760120000.00000      208837700.00006

ROW   3
      2996956.27273      208837700.00006       16067834.72727


SIMPLE CORRELATION COEFFICIENTS UNADJUSTED FOR DEGREES OF FREEDOM

ROW   1
  1.00000    .99119    .98513

ROW   2
   .99119   1.00000    .99167

ROW   3
   .98513    .99167   1.00000


PROBLEM NUMBER  0007
REPLACEMENT AND DELETION   1

DEPENDENT VARIABLE IS NOW      1
NUMBER OF VARIABLES DELETED    1
VARIABLES DELETED...  2
```

continued

```
                                      ANALYSIS OF VARIANCE FOR REGRESSION

      SOURCE OF VARIATION     D.F.                SUM OF                MEAN                  F
                                                  SQUARES               SQUARES               VALUE
DUE TO REGRESSION............   1              558989.25108          558989.25108          295.84019
DEVIATION ABOUT REGRESSION...   9               17005.47619            1889.49735
                     TOTAL...  10              575994.72727

THE RESULTS ABOVE ARE ACCURATE TO NO MORE THAN SIX DECIMAL PLACES
DESPITE THE POSSIBLE ILLUSION OF GREATER ACCURACY


                INTERCEPT (A VALUE) IS     -99.58846

  VARIABLE             MEAN           STANDARD        REG.      STD. ERROR    COMPUTED     PARTIAL
NO.    NAME                           DEVIATION       COEF.     OF REG.COEF.  T VALUE    CORR. COEF.
 3                  6174.54545       1267.58963       .18652      .01084      17.20001       .98513
DEPENDENT
 1                  1052.45455        239.99890

COMPARE CHECK ON FINAL COEFFICIENT......        .18652


      INCREMENTS FOR INDEPENDENT VARIABLES        *                  CUMULATIVE    REGRESSIONS
                                                  *
   VARIABLE         SUMS OF     PROP.    F VALUE  *   STD. ERROR      SUMS OF    PROP.VAR.     F         MULTIPLE
NO.    NAME         SQUARES     VAR.    EACH TERM *  OF ESTIMATE      SQUARES    = R SQ.      VALUE         R
 3             558989.25108   .97048   295.84019       43.46835   558989.25108   .97048   295.84019      .98513

PROPORTION OF VARIANCE SPE-
  CIFIED TO LIMIT VARIABLES    0.00000


                TABLE OF RESIDUALS

OBSERVATION       Y VALUE          Y ESTIMATE        RESIDUAL
     1          1440.00000         1377.82844        62.17156
     2          1360.00000         1314.41199        45.58801
     3          1241.00000         1248.01123        -7.01123
     4          1238.00000         1274.68344       -36.68344
     5          1055.00000         1144.12015       -89.12015
     6          1028.00000         1046.19768       -18.19768
     7           979.00000          980.72952        -1.72952
     8           906.00000          903.32414         2.67586
     9           825.00000          833.00648        -8.00648
    10           785.00000          754.66850        30.33150
    11           720.00000          700.01844        19.98156


VON NEUMANN RATIO                                    .88511
DURBIN-WATSON COEFFICIENT                            .80465


RATIO OF RANGES FOR THE SMALLEST RESIDUAL.....       .526
RATIO OF RANGES FOR THE LARGEST RESIDUAL......       .322

CRITICAL VALUE OF THE RATIO AT ALPHA = .10 ...       .517
```

continued

```
PROBLEM NUMBER  0007
REPLACEMENT AND DELETION   2

DEPENDENT VARIABLE IS NOW      1
NUMBER OF VARIABLES DELETED    1
VARIABLES DELETED...  3


                                              ANALYSIS OF VARIANCE FOR REGRESSION

     SOURCE OF VARIATION     D.F.                 SUM OF                MEAN                    F
                                                  SQUARES               SQUARES                 VALUE
DUE TO REGRESSION.............   1             565893.20526          565893.20526           504.18529
DEVIATION ABOUT REGRESSION...   9              10101.52202            1122.39134
                    TOTAL...   10             575994.72727

THE RESULTS ABOVE ARE ACCURATE TO NO MORE THAN SIX DECIMAL PLACES
DESPITE THE POSSIBLE ILLUSION OF GREATER ACCURACY


                   INTERCEPT (A VALUE) IS    -786.06513

  VARIABLE              MEAN            STANDARD         REG.       STD. ERROR      COMPUTED      PARTIAL
NO.     NAME                            DEVIATION        COEF.     OF REG.COEF.     T VALUE     CORR. COEF.
 2                  128400.00000       16613.60888       .01432       .00064        22.45407        .99119
DEPENDENT
 1                    1052.45455         239.99890

COMPARE CHECK ON FINAL COEFFICIENT......          .01432


      INCREMENTS FOR INDEPENDENT VARIABLES        *                    CUMULATIVE    REGRESSIONS
                                                  *
  VARIABLE            SUMS OF      PROP.     F VALUE   *   STD. ERROR       SUMS OF      PROP.VAR.      F          MULTIPLE
NO.     NAME          SQUARES      VAR.     EACH TERM  *  OF ESTIMATE       SQUARES      = R SQ.      VALUE          R
 2                 565893.20526   .98246   504.18529       33.50211      565893.20526    .98246    504.18529       .99119

PROPORTION OF VARIANCE SPE-
  CIFIED TO LIMIT VARIABLES     0.00000


                   TABLE OF RESIDUALS

OBSERVATION      Y VALUE          Y ESTIMATE         RESIDUAL
     1          1440.00000        1414.71738         25.28262
     2          1360.00000        1338.82833         21.17167
     3          1241.00000        1265.80301        -24.80301
     4          1238.00000        1194.20957         43.79043
     5          1055.00000        1124.04799        -69.04799
     6          1028.00000        1051.02268        -23.02268
     7           979.00000         980.86110         -1.86110
     8           906.00000         909.26766         -3.26766
     9           825.00000         837.67421        -12.67421
    10           785.00000         766.08076         18.91924
    11           720.00000         694.48732         25.51268


VON NEUMANN RATIO                                      2.53358
DURBIN-WATSON COEFFICIENT                              2.30325


RATIO OF RANGES FOR THE SMALLEST RESIDUAL.....        .487
RATIO OF RANGES FOR THE LARGEST RESIDUAL......        .270

CRITICAL VALUE OF THE RATIO AT ALPHA = .10 ...        .517
```

```
PROBLEM NUMBER  0007
REPLACEMENT AND DELETION   3

DEPENDENT VARIABLE IS NOW      1
NUMBER OF VARIABLES DELETED  -0


                                          ANALYSIS OF VARIANCE FOR REGRESSION

     SOURCE OF VARIATION     D.F.                   SUM OF                 MEAN                    F
                                                    SQUARES               SQUARES                VALUE
DUE TO REGRESSION...........    2              566060.26285          283030.13142            227.91778
DEVIATION ABOUT REGRESSION...   8                9934.46443            1241.80805
                     TOTAL...  10              575994.72727

THE RESULTS ABOVE ARE ACCURATE TO NO MORE THAN SIX DECIMAL PLACES
DESPITE THE POSSIBLE ILLUSION OF GREATER ACCURACY


                    INTERCEPT (A VALUE) IS    -697.49440

  VARIABLE              MEAN            STANDARD         REG.      STD. ERROR      COMPUTED      PARTIAL
NO.    NAME                             DEVIATION        COEF.    OF REG.COEF.     T VALUE     CORR. COEF.
 2                  128400.00000      16613.60888       .01242       .00521        2.38624        .64483
 3                    6174.54545       1267.58963       .02503       .06824         .36678        .12860
DEPENDENT
 1                    1052.45455        239.99890

COMPARE CHECK ON FINAL COEFFICIENT......         .02503


      INCREMENTS FOR INDEPENDENT VARIABLES         *                    CUMULATIVE    REGRESSIONS
                                                   *
  VARIABLE            SUMS OF      PROP.     F VALUE  *    STD. ERROR       SUMS OF      PROP.VAR.      F         MULTIPLE
NO.    NAME           SQUARES      VAR.     EACH TERM *   OF ESTIMATE       SQUARES      = R SQ.      VALUE          R
 2                 565893.20526   .98246    504.18529       33.50211     565893.20526    .98246    504.18529      .99119
 3                    167.05759   .00029       .13453       35.23930     566060.26285    .98275    227.91778      .99134

PROPORTION OF VARIANCE SPE-
  CIFIED TO LIMIT VARIABLES    0.00000


                  TABLE OF RESIDUALS

OBSERVATION     Y VALUE          Y ESTIMATE         RESIDUAL
     1         1440.00000        1410.46702         29.53298
     2         1360.00000        1336.10511         23.89489
     3         1241.00000        1263.82768        -22.82768
     4         1238.00000        1205.28290         32.71710
     5         1055.00000        1126.87998        -71.87998
     6         1028.00000        1050.37241        -22.37241
     7          979.00000         980.70509         -1.70509
     8          906.00000         908.19335         -2.19335
     9          825.00000         836.63276        -11.63276
    10          785.00000         763.99587         21.00413
    11          720.00000         694.53783         25.46217


VON NEUMANN RATIO                                 2.24696
DURBIN-WATSON COEFFICIENT                         2.04269


RATIO OF RANGES FOR THE SMALLEST RESIDUAL.....      .488
RATIO OF RANGES FOR THE LARGEST RESIDUAL......      .131

CRITICAL VALUE OF THE RATIO AT ALPHA = .10 ...      .517
```

continued

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 4.185 seconds for central-processor time and 48.982 seconds for peripheral-processor time with a memory useage of 37,300 words. Chargeable computer time was $1.75.

Charge to user = computer time + postage and handling + network overhead
= $1.75 + $15.00 + network overhead
= $16.75 + network overhead

CONTENTS—BMD29

pages

1,2 Identification & Abstract
3–11 User Instructions
13–17 I/O
19 Cost—Contents

DESCRIPTIVE TITLE	Student's T Test
CALLING NAME	STDNTF1 NUCC018
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

STDNTF1 computes 50 T tests between two groups. Such tests compare an appropriate sampling (T) distribution with the normal distribution. The program also tests for consistency of performance on all variables within the test. Also, the handling of multiple jobs is possible. (See STDNTF2, EIN No. 000 0003.)

USER INSTRUCTIONS

Description of Input

Data consist of the score cards for each group. Variable format may be used.

Cards	*Columns*	*Contents*
1	1– 2	Number of jobs to be done
2	1– 3	Number of subjects in the first group
	4– 6	Number of subjects in the second group
	7– 8	Total number of variables to be tested
3	1–72	Continuation of format; this card *must* be the same
4	1–72	Continuation of format; this card *must* be present (even if not needed)
5 ⋮ .	⋮ .	Score cards of the first group, followed by score cards of the second group; then header card (card 2 above) for the next job, then cards 3,4,5,etc. Cards 2–5 (and on) are to be repeated for each subsequent job. (If no further jobs are to be done, simply end with the last score card.)

Description of Output

Only printout is obtained. 1. Means and standard deviations of the first group. 2. Means and standard deviations of the second group. 3. Number of degrees of freedom. 4. Variable number and the value of student's T for the difference between the two group means for each variable. 5. A table of degrees of freedom and F ratios, to determine the appropriateness of the assumption of homogeneity of variances; T's are computed and printed whether or not this assumption is rejected. T's are computed using a pooled estimate of the variance. 6. The results for the second group.

⋮

etc.

Job Deck Structure

JOB Card
LIBRARY (STDNTF1)
LGO.
7–8–9 (EOR Card)

Card 1—Number of Jobs
Card 2—Header Card
Cards 3,4—Format Cards (two required)
Score Cards for group 1
Score Cards for group 2

6–7–8–9 (EOI Card)

SAMPLE INPUT

```
VLORR.CH             CM17400.     STDNTF1
LIBRARY(STDNTF1)
LGO.
'  END OF RECORD
03
  5  4  2 1
(2F2.1)

1020
2010
3010
2020
1020
2010
3020
1030
2010
  5  4  2 1
(2F2.1)

1010
  10
2010
10
  20
1020
2020
  10
30
  5  4  2 1
(2F2.1)

1020
 0
20 .
1030
1020
2030
2020
1010
2030
 1
  3  3  401
(20F4.0)

  2.  1.  5.  7.
  2.  1.  1.  5.
  3.  2.  5.  6.
  8.  8.  8.  8.
  5.  5.  5.  5.
  4.  4.  4.  4.
'END OF INFORMATION
'END OF INFORMATION
```

continued

SAMPLE OUTPUT

```
GROUP 1 MEANS
      1.800

GROUP 2 MEANS
      2.000

GROUP 1 STD. DEV.
       .748

GROUP 2 STD. DEV.
       .707

NUMBER OF DEGREES OF FREEDOM =         7

VALUES OF STUDENTS T

VARIABLE  1 =      -.3600

VARIABLE   NDF 1   NDF 2   F RATIO
    1          4       3        1.05
               .
               .
               .
GROUP 1 MEANS
      1.000

GROUP 2 MEANS
      1.750

GROUP 1 STD. DEV.
       .632

GROUP 2 STD. DEV.
       .433

NUMBER OF DEGREES OF FREEDOM =         7

VALUES OF STUDENTS T

VARIABLE  1 =     -1.7839

VARIABLE   NDF 1   NDF 2   F RATIO
    1          4       3        2.00
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 0.195 seconds of central-processor time and 11.923 seconds of peripheral-processor time. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—STDNTF1

pages

1 Identification & Abstract
3 User Instructions
5,6 I/O
7 Cost—Contents

DESCRIPTIVE TITLE	Northwestern University Correlation Analysis, Version 1
CALLING NAME	NUCORR1 NUCC070
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

NUCORR1 may be used to compute sums, sums of squares, crossproducts, means, standard deviations, and all or any desired section of the correlation matrix. There is also the capability of classifying data into groups on the basis of a single property.

NUCORR1 uses a maximum-likelihood estimator that deals with the principle of point estimates. This method is quite consistent and, for large numbers of samples, very efficient and hightly accurate. The basis concept of point estimation is the consideration of every possible value of the parameter and the calculation of the probability that that particular sample would occur in the normal distribution if it were the true value of the parameter. NUCORR1 also serves as an asymptotic estimator in that, as the size of the sample increases, the parameter will approach a limit (defined by the preceding values).

USER INSTRUCTIONS

Description of Input Data

TITLE1 Card (required)

Columns	*Contents*
1– 6	TITLE1
7–72	Alphanumeric information that is written as the top line of every page of results. Each new TITLE1 card replaces the last TITLE1 card

ONEWAVBEGIN*, ONEWAVFINISH CARDS (used only if one-way analysis of variance is desired)

Columns	*Contents*
1– 6	ONEWAV
7–12	BEGIN* at beginning of first group being tested for one-way analysis of variance, and FINISH at end of last group being tested

SETUP Card (required)

Parameter	*Columns*	*Contents*
	1– 6	SETUP*
	7–12	Problem number
KINDPR	13	Value indicates which process is to be performed on subsequent data 1: read and accumlate sums and sums of squares for the group and compute and write means and standard deviations for each variable; may be used with missing-data options 1 or 2: perform computations of option 1, plus sums of crossproducts and simple correlations. Each correlation (with related statistics) will be written on one line. Columns 20–40 of this card must be completed in detail; may

continued

Parameter	*Columns*	*Contents*
		be used if "odd-shaped" section of correlation matrix is desired or MDATSW= 1 or 2. A correlation T test is given 3: compute sums of crossproducts and simple correlations as matrices by rows in sections. *Ignore* Cols. 20–40; may *not* be used with the missing-data options 1 or 2 4: compute as in option 3, except sums of crossproducts matrix are not to be written out; may *not* be used with the missing-data options 1 or 2
MDATSW	14	"Missing-data switch" 0: no missing data exist. All data vectors containing missing-data codes are ignored. Actual M will again be the same for all variables but, in general, not equal to the number of observations. 2: missing data exist. However, only valid scores from incomplete data vectors are salvaged. Each correlation is computed with only those observations that have valid scores for both variables involved.
KDARR	15	Data arrangement 0: alphanumeric identification is first, followed by variables 1: variables are followed by alphanumeric identification *Note:* Every observation of the set of variables *must* have some identification, and this information must be read by the variable-format statement, using the A specification. This identification is *not* included in the count of the number of variables.

continued

Parameter	*Columns*	*Contents*
NBIAS	16	Value of variance bias 0 or 1 subtracted from N in denominator of variance (usually 1)
NVARRD	17–19	Number of variables to be read in each data vector, excluding the identification; number must be ≤ 200. If analysis of variance is desired, the number must be ≤ 100. If KINDPR=2, then the maximum value of NVARRD may be computed so that the maximum number of correlations is ≤ 2500

If KINDPR ≠ 2, Cols. 20–34 may be left blank. If KINDPR = 2, Cols. 20–34 must be filled in completely and will be used by the program to determine the pattern of output. See Example on page 9 for an illustration. For the "normal" case, which corresponds to section A (or Run 1) of the example, the usual values are NTR = LCTR = 1, LCOL = LRSFC = NVARRD, and JST = KST = KFS = 1.

Parameter	*Columns*	*Contents*
NTR	20–22	Number of first variable to be correlated with variable 1 (usually equal to 1)
LCOL	23–25	Number of last variable to be correlated with NVARRD (usually equal to NVARRD)
LCTR	26–28	Last column in top row. Number of last variable to be correlated with NTR (equal to 1 for triangular-shaped sections)
LRSFC	29–31	Last variable to be correlated with variable 1 (usually equal to NVARRD)
JST	32–34	Increment by which to step row subscript (usually 1)
KST	35–37	Increment by which to step column subscript (usually 1)
KFS	38–40	Increment by which to step last and/or first column subscript (at elast 1)
	41–42	=0 if input from cards =tape number if input is from data tape

VNAME Cards (1 card required for each variable)

The Variable–Name Card is used to identify variables in the output. Each Variable–Name Card will identify the variable that cor-

continued

responds with it in order of variable input—i.e., nth card identifies nth variable. The set of VNAME cards is followed by a blank card to signal end of name cards.

The Variable-Name Card is in the following format.

Columns	*Contents*
1–6	VNAME*
7–24	Alphanumeric identification of variable
25	Missing-data process code (see below)
26–37	Exclusion code (punch a decimal point!)

Note: (a) if no identification is desired, Cols. 7–24 must be blank.

(b) MDATSW = 2 is an indication that the missing-data codes (see below) are to be used. (Then, if, e.g., only blanks in the data are to be omitted, put an 8 in Col. 25 and nothing in Cols. 26–37.)

Missing-Data-Process Codes for VNAME* Cards

0 (or blank): No missing data
1: omit scores = 0
2: omit scores < 0
3: omit scores ≤ 0
4: omit scores ≥ exclusion code
5: omit scores as for 1 *or* 4 above
6: omit scores as for 2 *or* 4 above
7: omit scores as for 3 *or* 4 above
8: omit scores that are all blank only
9: omit scores as for 8 *or* 4 above

(*Note:* A blank variable score is entered into the machine as –0)

continued

Variable-Format Card

Columns	*Contents*
1– 6	FMTDAT
7–72	Variable format including parentheses. If more than one Variable-Format Card is needed, the format statement can be continued on up to 9 additional cards. The FMTDAT should be repeated in Cols. 1–6 on all continuation cards. The format must be E or F fields, except for the ID, which is A format. A blank card must follow the set of Variable-Format Cards.

End-of-Group Card

This card signals the end of a group of data. The program prints out the results for the data that it has processed and proceeds to the next group of data.

Columns	*Contents*
1– 6	ENDGRP
7–72	Alphanumeric information printed as second line on each page of output

Preparation of the Data Deck

The data input should correspond to the Variable-Format Card. The field width of each variable and the order of variables must remain fixed for all observations. Start a new card for the second and each subsequent case (set of observations).

Description of Output

The output includes the number of variables, the kind of process, the variance bias, and the missing-data switch option used. Each variable is listed with the number of observations for that variable and the means, standard deviation, standard error, variance, sum of squares, and sums of the observations for each variable.

In addition to this, correlation coefficients, the numerator of covariance, intercept on J axis, correlated T test, standard deviations, and means are calculated between variables.

continued

Limitations

1. Number of variables (M) may be up to 200 for process 1 (see below)
2. M ≤ 100 if analysis of variance or correlations are desired
3. M ≤ 50 variables if missing data are opted
4. Maximum number of correlations = 2500
5. Number of observations (per group) ≤ 999

Job Deck Structure

Job Card

LIBRARY (NUCORR1)

LGO.

7–8–9 (EOR Card)

I. Analysis of Variance desired:

ONEWAVBEGIN* (only in first group of data being tested for analysis of variance)

TITLE1 card

SETUP* card

Variable-Name Card(s)

Blank card (see Variable-Name Card section)

FMTDAT card(s)

Blank card (see FMTDAT section)

Data Input Cards for first group. (see Preparation of the Data Deck)

Blank set of Data Cards (one set of observations)

End-of-Group Card

Repeat through last group of data

ONEWAVFINISH card (only in last group of data being tested for analysis of variance)

continued

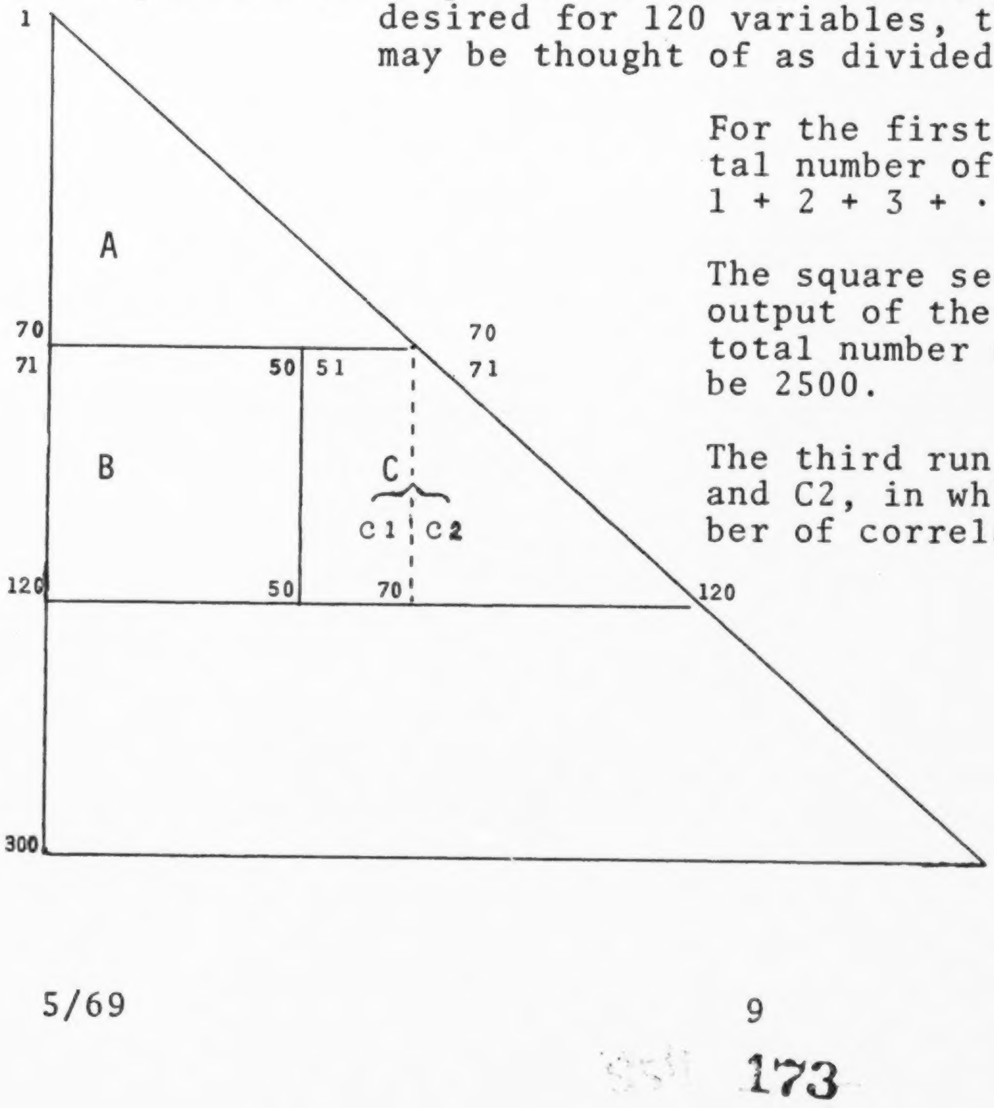
II. Analysis of Variance *not* desired:

TITLE1 card
SETUP* card
VNAME* card
Blank card (see VNAME* card section)
FMTDAT card(s)
Blank card (see FMTDAT section)
Data Input cards (see Preparation of the Data Deck)
blank set of data cards (one set of observations) (see Preparation of the Data Deck)
ENDGRP card

6–7–8–9 (EOI card)

Example

If KINDPT = 2, it is possible to get correlations and related statistics for large numbers of variables by dividing the total output into two or more runs. The numbers in Cols. 20–40 determine the pattern of output for each run. For example, if results are desired for 120 variables, the correlation matrix may be thought of as divided in the following way.



For the first run (Sec. A), the total number of correlations is $1 + 2 + 3 + \cdots + 70 = 70X71/2 = 2485$.

The square section (B) might be the output of the second run. Here, the total number of correlations would be 2500.

The third run could be Sec. C = C1 and C2, in which case the total number of correlations would be

$$C_1 = 50*20 = 1000$$

$$C_2 = \sum_{i=1}^{50} i$$

$$= 50*51/2 = 1275$$

Total for C = 2275

continued

Columns 17–40 of the SETUP* cards for these runs would be as follows.

Cards	*Columns*	*Run 1*	*Run 2*	*Run 3*
NVARRD	17–19	70	100	70
NTR	20–22	1	51	21
LCOL	23–25	70	50	70
LCTR	26–28	1	50	21
LRSFC	29–31	70	100	70
JST	32–34	1	1	1
KST	35–37	1	1	1
KFS	38–40	1	1	1

For Run 1, variables 1–70 of the data are needed.

In Run 2, the variables needed are numbers 1–50 and 71–120, or a total of 100 variables to read. (The variable format should indicate that variables 51–70 are to be skipped.) Note that the numbering of variables is relative to those actually used; i.e., variable 71 is renumbered as variable 51, 72 as 52, etc. If desired, the variable numbers may be punched on the Variable-Name Cards so that the original numbers will appear on the output along with the number relative to this run.

In Run 3, the variables needed are numbers 51–120, or a total of 70. In this case, variable 51 is 1 relative to Sec. C. Therefore, NTR = 21, relative to the beginning of Sec. C and LCTR = 20.

SAMPLE INPUT

```
VLORR,CH              ,CM61700.   NUCORR1
LIBRARY(NUCORR1)
LGO.
TITLE1 TEST OF SOME GARBAGE DATA
SETUP*000005220100500100500100500100100
VNAME*GAR1                  8
VNAME*GAR2                  8
VNAME*GAR3                  8
VNAME*GAR4                  8
VNAME*GAR5                  8

FMTDAT(A6,5F6.1)

 00250 00025 02500 00150 00034 00064
 00350 00022 02200 00043 00041 00082
 00175 00009 00130 00180 00015 00023
 00300 00023 02300 00200 00033 00064
 00200 00010 00060 00330 00013 00016
 00550 00007 00140 00340 00016 00012
 00600 00006 00080 00500 00011 00027
 00130 00008 00270 00150 00019 00048
 00500 00018 00360 00180 00027 00050
 00500 00003 00100 00140 00014 00012
 00300 00008 00270 00100 00025 00013
 00200 00006 00300 00150 00021 00020
 00200 00008 00100 00250 00018 00023
 00100 00022 02200 00110 00046 00118
 00400 00013 01300 00280 00017 00050
   :           :           :         :
 00200 00025 02500 00100 00035 00150
 00400 00009 00075 00190 00017 00023
 00300 00007 00350 00260 00012 00042
 00800 00020 02000 00220 00030 00072
 00600 00012 00400 00120 00020 00036
 00800 00026 00160 00110 00035 00056
 00150 00015 00300 00160 00029 00036
 00700 00010 00090 01000 00012 00026
 00800 00028 02800 00420 00040 00108
 00200 00034 03400 00090 00042 00106
 00600 00004 00080 00360 00011 00016
 00300 00018 00160 00110 00032 00012
 00600 00003 00040 00130 00015 00007
 00600 00014 00090 00070 00029 00028
 00180 00012 00240 00150 00021 00025
 00500 00012 00200 00410 00016 00014
 00180 00024 02400 00110 00038 00106
 00600 00010 00500 00100 00026 00032
     1   1.0   4.0
     2         2.0   5.0   6.0
     3         8.0         9.0   7.0
     4   8.2   7.6         8.3   9.7
```

SAMPLE OUTPUT

```
NUCORRV1 PROGRAM    PROBLEM        5                                                                      PAGE    1
NO.SELECTORS    1                      TEST OF SOME GARBAGE DATA
NO.VARIABLES    5   MISS.DATA SW. 2
KIND PROCESS    2   VARIANCE BIAS 1      THIS IS THE SECOND LINE OF OUTPUT THANK YOU

VARIABLE NAME  AND NO.   NO.      MEAN    STANDARD    STANDARD       VARIANCE  SUM OF SQUARES       SUM   SUM OF SQUARES
                         OBS.             DEVIATION   ERROR                    OF MOMENTS                 OF RAW DATA

GAR1                 1   47     1.7255     1.3328      .1944    17.76290E-01  81.70936E.00  81.10000E+00  22.16500E.01

GAR2                 2   49    91.5122   115.7428    16.5347    13.39639E+03  64.30270E+04  44.84100E+02  10.53377E+05

GAR3                 3   46    22.4239    19.4584     2.8690    37.86303E+01  17.03836E+03  10.31500E+02  40.16863E+03

GAR4                 4   48     2.9500     1.7064      .2463    29.11915E-01  13.68600E+01  14.16000E+01  55.45800E+01

GAR5                 5   47     5.5511     4.2314      .6172    17.90473E+00  82.36174E+01  26.09000E+01  22.71890E+02


NUCORRV1 PROGRAM    PROBLEM        5                                                                      PAGE    2
NO.SELECTORS    1                      TEST OF SOME GARBAGE DATA
NO.VARIABLES    5   MISS.DATA SW. 2
KIND PROCESS    2   VARIANCE BIAS 1      THIS IS THE SECOND LINE OF OUTPUT THANK YOU

VARIABLES CORRELATED          CORR.    NO.   .......MEANS........  STANDARD DEVIATIONS  CORR.   SLOPE     INTERCEPT     NUMERATOR OF
NAMES AND/OR NUMBERS *J.  K   COEFF.   OBS.  VARIABLE J VARIABLE K VARIABLE J VARIABLE K T-TEST  (J/K)     ON J-AXIS     COVARIANCE
*GAR1                   1
   GAR1                   1  1.0000    47      1.7255     1.7255     1.3328     1.3328  0.000  10.00E-01   0.           38.403400E+02
*GAR2                   2
   GAR1                   1   .4841    47     95.1936     1.7255   116.7870     1.3328 73.613  42.42E+00  21.99E+00    16.840888E+04
   GAR2                   2  1.0000    49     91.5122    91.5122   115.7428   115.7428  0.000  10.00E-01   0.           31.508321E+06
*GAR3                   3
   GAR1                   1  -.0619    45     22.8111     1.5978    19.4983      .9358 88.007 -12.90E-01  24.87E+00   -33.974500E+02
   GAR2                   2   .0092    46     22.4239    97.0543    19.4584   117.3731 -4.341  15.26E-04  22.28E+00    45.748850E+03
   GAR3                   3  1.0000    46     22.4239    22.4239    19.4584    19.4584  0.000  10.00E-01   0.           78.376473E+04
*GAR4                   4
   GAR1                   1   .7177    46      2.7522     1.7413     1.4076     1.3431 35.693  75.21E-02  14.43E-01    36.046000E+02
   GAR2                   2   .2954    48      2.9500    93.3354     1.7064   116.2544 -5.403  43.35E-04  25.45E-01    13.437288E+04
   GAR3                   3  -.2821    46      2.7022    22.4239     1.2366    19.4584 -6.658 -17.93E-03  31.04E-01   -20.241030E+03
   GAR4                   4  1.0000    48      2.9500     2.9500     1.7064     1.7064  0.000  10.00E-01   0.           65.692800E+02
*GAR5                   5
   GAR1                   1   .6741    46      5.5196     1.7413     4.2726     1.3431 18.011  21.44E-01  17.86E-01    82.184900E+02
   GAR2                   2   .8079    47      5.5511    95.2787     4.2314   116.7205 -5.360  29.29E-03  27.61E-01    89.219870E+04
   GAR3                   3  -.1410    45      5.4267    22.8111     4.2736    19.4983 -5.798 -30.90E-03  61.31E-01   -24.552600E+03
   GAR4                   4   .5934    47      5.5511     2.8851     4.2314     1.6639 13.723  15.09E-01  11.98E-01    94.623100E+02
   GAR5                   5  1.0000    47      5.5511     5.5511     4.2314     4.2314  0.000  10.00E-01   0.           38.710020E+03
```

continued

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 1.21 seconds for central-processor time and 28.412 seconds for peripheral-processor time with a memory useage of 61,700 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—NUCORR1

pages
1 Identification & Abstract
3–10 User Instructions
11–12 I/O
13 Cost—Contents

DESCRIPTIVE TITLE	Upper- and Lower-Case Greek and Roman Alphabetic Plotting
CALLING NAME	SCRIPT
INSTALLATION NAME	University of Notre Dame Computing Center
AUTHOR(S) AND AFFILIATION(S)	Nicholas DiCianni
LANGUAGE	FORTRAN
COMPUTER	UNIVAC 1107
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Leonard Kilian Elizabeth Hutcheson Computing Center University of Notre Dame

FUNCTIONAL ABSTRACT

The SCRIPT subroutine provides useful and flexible character sets for the CalComp plotter. Two fonts are available, Roman and Greek, each in upper and lower case. Special Control Characters allow the user to change case or font and permit backspacing, superscripting, and subscripting. The routine also provides for plotting at angles. Italics may be specified also.

USER INSTRUCTIONS

Description of Input

CALL SCRIPT (XO,YO,HO,THETA,BETA,ADS,NC)

Name	*Form*	*Contents*
SCRIPT	subroutine	
XO	real	X coordinate of the start of the plot
YO	real	Y coordinate of the start of the plot
HO	real	Height (in inches) of the character string to be plotted
THETA	real	Angle (in degrees) with respect to the X axis for plotting the characters = 0: parallel to X axis = 90.0: perpendicular to X axis
BETA	real	Angle (in degrees) that will produce italics (22° recommended)
ADS	alphanumeric	Number of characters in the string, followed by an H, followed by the string of Control and Plot Characters, Holerith expression
NC	integers	Number of characters in the string, including blanks and Control Characters

Control Characters

The characters to be plotted are interspersed with appropriate Control Characters, forming a string of meaningful instructions. The special Control Characters are

Card Control	*Reference Code*	*Use*
2–8	𝓈	Change case
12–7–8	𝒻	Change font
0–5–8	↑	Plot a character as a *super*script
0–6–8	↓	Plot a character as a *sub*script
11–6–8	←	Backspace
0–7–8	ℓ	Lock
11–0	*u*	Unlock

continued

The SCRIPT subroutine assumes that characters are to be plotted as lower-case Roman. It functions similar to a typewriter with respect to shifts and locks. A shift applies to only the next plotable character. A lock, occurring after a shift, will hold the Control Character in effect until an unlock occurs.

Examples

Character String	*Result*
D	d
𝓈D	D
𝓰D	δ
𝓰 𝓈D	Δ
𝓈CAL 𝓈COMP	CalComp
𝓰L=𝓰ℓA+B-C*u*	λ=α+β-γ
𝓰L=𝓰A+B-C	λ=α+b-c

The 0–5–8, and 0–6–8 control codes specify super- and sub-scripting. The next noncontrol character will be plotted one-half the height of the scripted character. A lock may be used with super- and subscripted characters to provide multiple characters at the same level. Note also that, by the use of the lock, multiple levels of sub- and super-scripting may be obtained.

Examples

Character String	*Result*
𝓈A↑2	$A^{2}{}_{3}$
𝓈A↑ℓ2↑3*u*	A^{2}
𝓈A↓2	A_{2}
𝓈A↓ℓ2↓3*u*	$A_{2_{3}}$
𝓈A↑ℓB↓2*u*	$A^{b_{2}}$

The backspace Control Character causes the next character to be plotted with the same X coordinate as the previous plotted character. If an unlock appears before the backspace, the next character will have the X coordinate of the first character following the lock that precedes the unlock. If multiple unlocks precede the backspace, the X coordinate corresponding to the appropriate lock command will be used.

Examples

Character String	*Result*
𝓈A↑2←↓3	A^{2}_{3}

continued

Character String	*Result*
*s*A↑ℓcd*u*←↓3	A_3^{cd}
*s*A↑ℓcd↑ℓef*u*←↓*2u*←↓i	$A_i^{cd_2^{ef}}$

The subroutine automatically controls spacing between characters. Since all characters do not take the same amount of space, it is difficult, if not impossible, for the user to compute the length of the resulting plot. For this reason, if it is desirable to compute the length of the plot (for example, to center the line), a call of SCRIPT with NC negative will cause the plotted string length to be returned in XO. No plot will be produced. The proper initial X coordinate may then be calculated and SCRIPT called with the appropriate XO and NC positive.

The complete character set is reproduced below (reduced 60%). Character codes not containing characters represent the various Control Characters.

SCRIPT CHARACTER SET

Card Code	7 8	12 5 8	11 5 8	12 7 8	11 7 8		12 1	12 2	12 3	12 4	12 5	12 6	12 7	12 8	12 9	11 1	11 2	11 3	11 4	11 5	11 6
Octal	00	01	02	03	04	05	06	07	10	11	12	13	14	15	16	17	20	21	22	23	24
Decimal	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
Printer							A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Font 1 Lower	=	{	}		≥		a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
Font 1 Upper	≠	[	]		≤		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Font 2 Lower	=	↓	→		≤		α	β	γ	δ	ε	φ	∨	η	ι	ξ	κ	λ	μ	ν	ο
Font 2 Upper	≠	↑	←		≥		A	B	Γ	Δ	E	Φ	∧	H	I	Ξ	K	Λ	M	N	O

continued

SCRIPT CHARACTER SET

Card Code	11 7	11 8	11 9	0 2	0 3	0 4	0 5	0 6	0 7	0 8	0 9	12 4 8	11	12	12 6 8	3 8	6 8	2 8	11 3 8	11 4 8	0 4 8
Octal	25	26	27	30	31	32	33	34	35	36	37	40	41	42	43	44	45	46	47	50	51
Decimal	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Printer	P	Q	R	S	T	U	V	W	X	Y	Z	)	-	+	<	=	>		$	*	(
Font 1 Lower	p	q	r	s	t	u	v	w	x	y	z	)	-	+	<	=	>		$	*	(
Font 1 Upper	P	Q	R	S	T	U	V	W	X	Y	Z	)	-	+	<	=	>		$	*	(
Font 2 Lower	π	θ	ρ	σ	τ	υ	∩	ω	χ	ψ	ζ	)	-	+	<	=	>		≡	*	(
Font 2 Upper	Π	Θ	Ρ	Σ	Τ	ϒ	υ	Ω	Χ	Ψ	Ζ	)	-	+	<	=	>		∴	*	(

SCRIPT CHARACTER SET

Card Code	0 5 8	5 8	12 0	11 0	0 3 8	0 6 8	0	1	2	3	4	5	6	7	8	9	4 8	11 6 8	0 1	12 3 8	0 7 8
Octal	52	53	54	55	56	57	60	61	62	63	64	65	66	67	70	71	72	73	74	75	76
Decimal	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62
Printer		:			,		0	1	2	3	4	5	6	7	8	9	'		/	.	
Font 1 Lower		:	?		,		0	1	2	3	4	5	6	7	8	9	'		/	.	
Font 1 Upper		;	!		,		0	1	2	3	4	5	6	7	8	9	"		/	.	
Font 2 Lower		≤	⊂		,		0	1	2	3	4	5	6	7	8	9	∨		/	.	
Font 2 Upper		≥	⊃		⌐		∞	∘	∫	≠	%	√	∝	±	×	|	⇒		+	~	

SAMPLE INPUT

```
      CALL SCRIPT (1., 9., .2, 0., 0., 33HδℓILLUSTRATION FOR SCRIPT ROUTINE, 33)

      CALL SCRIPT (1., 7., .15, 30., 0., 26HA↓ℓN+2u = A↓ℓN+1u + A↓N←↑2, 26)

      CALL SCRIPT (1., 6., .15, 0., 25., 30HδITALICS MAY ALSO BE SPECIFIED, 30)

      CALL SCRIPT (1., 5., .25, 0., 0., 24HʆδL = ʆAδA + ʆBδB + ʆCδC, 24)

      INTEGER IN(8)

    1 FORMAT (8A6)

      X = 1.
      Y = 4.
      H = .2
      DY = .3

      CALL SCRIPT (X, Y-DY, H+DY, 0., 0., 2HδN, 2)

      CALL SCRIPT (X+.05, Y-DY, H+DY, 0., 0., 2HδN, 2)

      DO 10 I = 1,9

      READ 1, IN

      CALL SCRIPT (X, Y, H, 0., 0., IN, 48)

   10 Y = Y - DY
```

This part of the example is a portion of a FORTRAN program that uses SCRIPT.

DATA CARDS

```
    OT UNTIL A MACHINE CAN WRITE A SON-
    NET OR COMPOSE A CONCERTO BECAUSE OF
THOUGHTS AND EMOTIONS FELT, AND NOT BY THE
CHANCE FALL OF SYMBOLS, COULD WE AGREE
THAT MACHINE EQUALS BRAINS - THAT IS, NOT
ONLY WRITE IT BUT KNOW THAT IT HAD WRITTEN
IT.
                    δℓGEOFFREY JEFFERSON
                     δLISTER δORATION FOR 1949
```

SAMPLE OUTPUT

ILLUSTRATION FOR SCRIPT ROUTINE

Italics may also be specified

$$\Lambda = \alpha A + \beta B + \gamma C$$

Not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt, and not by the chance fall of symbols, could we agree that machine equals brains - that is, not only write it but know that it had written it.

GEOFFREY JEFFERSON
Lister Oration for 1949

COST ESTIMATE

For the job listed on the Sample Input, the total running time on the Central Computer was 1 minute 20 seconds (@ $8/minute). This includes searching the library tape, bringing in SCRIPT, and compiling the FORTRAN program. (Time from end of allocation to run termination was 41 seconds.) There is no additional charge for plotter time.

Charge to user = computer time + postage and handling + network overhead
= $10.67 + $10.00 + network overhead
= $20.67 + network overhead

CONTENTS—SCRIPT

pages

1 Identification & Abstract
3– 6 User Instructions
7– 8 I/O
9 Cost—Contents

DESCRIPTIVE TITLE	Automatic Interaction Detector
CALLING NAME	AID NUCC113
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	J. Sonquist The University of Michigan
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

AID was originally programmed for the IBM 7090 in the MAD language at The University of Michigan. A detailed discussion of the theory, methods, and control parameters of the program are contained in Ref. 1. Since 1964, two parameters have been added to the main-parameter card.

AID is focused on a particular kind of data-analysis problem, characteristic of many social-science research situations, in which the purpose of the analysis involves more than the reporting of descriptive statistics but may not necessarily involve the exact testing of specific hypotheses. In this type of situations the problem is often one of determining which of the variables, for which data have been collected, are related to the phenonmenon in question, under what conditions, and through what intervening processes, with appropriate controls for spuriousness.

AID is useful in studying the interrelationships among a set of up to 37 variables. Regarding one of the variables as a dependent variable, the analysis employs a nonsymmetrical branching process, based on variance-analysis techniques, to subdivide the sample into a series of subgroups that maximizes one's ability to predict values of the dependent variable. Linearity and additivity

continued

assumptions inherent in conventional multiple-regression techniques are not required. AID will handle variables that are only nominal scales, i.e., mere classifications.

REFERENCES

1. Morgan, J.N., and Sonquist, J.A., "The Detection of Interaction Effects: A Report on a Computer Program for the Selection of Optimal Combinations of Explanatory Variables," Univ. Mich. Inst. Soc. Res. Survey Res. Ctr. Monograph No. 35 (1964); copies may be obtained from the EIN office for the cost of duplication and mailing.

USER INSTRUCTIONS

Description of Input Data

It is assumed that the data have been punched on cards, one or more cards per observation. Original input may *not* be a data tape. Input data may be punched anywhere on the card except in Col. 1. *Column 1 of the data cards may contain any legal character except an alphanumeric E.* A legal character is defined as any punching pattern obtainable from a *single* depression of a key on a keypunch.

Since several analyses may be performed during one machine run, it is desirable to list the types of variables that may be entered into the computer. Each analysis may use its own subset of the variables.

Variables entered into the computer are of five types:

(1) identifiers
(2) sample subset selectors (filters)
(3) predictors
(4) dependent variables
(5) weights

With the exception of identifiers, any variable may be used for types (2)–(5), provided that it meets the restrictions made by the program on the values that a variable may legally assume.

The only restriction on where variables may be placed on the data cards is that *no variable to be used in an analysis may be punched in Col. 1.*

All input variables, *except those which are to be used as identifiers,* are supplied to the program in integer mode. Variables to be used as identifiers must be supplied to the program in character (BCD) mode.

Program Control Cards

Label Card—Type 1 Card

Columns	
1	1 (required)
2–79	Alphanumeric identification. If card residuals are requested, place the project identifier

continued

starting in Col. 2 of this card, followed by a deck-identification number. The contents of Cols. 2–13 of this card will be punched into the card residual output from this analysis. All BCD characters are legal project and deck identifiers. The entire contents of Cols. 2–79 will be printed on the output statistics. If this run is a subset of the sample—i.e., a partial data deck has been entered into the computer—this information should be punched on the label card somewhere after Col. 13.

Main-Parameter Card—Type 2 Card. All parameters are punched right-adjusted.

Columns	
1	2 (required)
5	0 or blank for an abbreviated form of output 1: full printout
6	Number of variable-format cards
7	C if input data are on cards and are not to be saved on tape. W if input data are on *cards* and *are* to be written on binary tape and saved for subsequent analysis. T if the input are already on binary *tape* as the result of a previous run
10–13	Number of observations (cases)
17–19	The total number of all input variables *including identifiers,* predictors, sample subgroup selection variables, dependent variables, and weight(s) *AND* when Col. 7 is T this includes residuals left on tape from any previous analyses performed on this run. Take all the variables to be used in all analyses and assign integers to them, starting with the leftmost variable on the first (merged) data deck as variable number 1. The last field number on the last merged deck is variable NV. The first residual placed on tape is numbered one larger than this; the second residual is numbered two larger than this. Subsequent values of NV for succeeding runs must be increased by the appropriate amount. Range ($2 \leq NV \leq 100$).

continued

Secondary-Parameter Card—Type 3 Card

Columns	
1	3 (required)
6– 7	Number of predictor variables to be used (NP) *Restriction:* $1 \le NP \le 36$
11–13	Index number of variable to be used as weight (WT) *Restriction:* $0 \le WT \le NV$ 000 Run will be unweighted
14–19	P1—this is the *proportion* of the total sum of squares that must be contained in any group if that group is to become a candidate for splitting. 2% has been found to work reasonably well, e.g., punch the proportion .020. Note that the decimal point is punched in the field. Other values may be punched at the user's option. The range is $.00001 \le P1 \le 1.0$
20–25	P2—the best split on the i^{th} candidate group must reduce the unexplained sum of squares by P2 *proportion* of the total sum of squares or that group will not be split, and it will not become a candidate group again even though it may meet the P1 requirement above. The range is $0 \le P2 \le P1$. The decimal point is punched in this field as above. The proportion .0060 has been found to work well with samples of 1500–3000. Other values may be punched at the user's option
26–28	MAXGP—the maximum allowable number of final groups into which the input data may be split, regardless of P1 or P2. Thus, the splitting process will always stop when the sample has been divided into MAXGP number of unsplit subgroups. MAXGP may not be larger than 63, i.e., 62 splits, 125 groups in all. Fifty has been found to be a satisfactory maximum number of splits. The range is $1 \le MAXGP \le 63$
29-31	MSIZE—minimum number of observations that must be contained in a group if that group is to become a candidate for splitting. Its purpose is to prevent small groups with somewhat unstable means from being further split, since the splits are likely to be heavily influenced by sampling errors. Normally, MSIZE should not be smaller than 25. Range $001 \le MSIZE \le 999$

continued

35–37	This is the index number of the variable to be used as the dependent variable (right-adjusted). For example, if the dependent variable is the 14th variable, punch 014. *No variable to be used as a dependent variable may have a value larger than* 999,999 or less than 99999 before scaling
38–49	Name of independent variable
50–80	Contain various optional parameter

Predictor/List Cards—Type 4 Cards

Use only as many PL cards as are needed. Values of all variables must be in the range 0 < Xi < 63. The maximum number of preditors is 36 (maximum number of predictor cards is 9). Each predictor-list card contains 4 fields, 1/predictor. The last predictor card may contain only as many fields as needed.

Columns	
1	4 (required)
Predictor #1:	
3- 5	Variable number
7	Type of predictor M (monotonic) or F (free); M if the predictor code ordering for that predictor is to be *maintained* during the partition scan; F if the categories of that predictorare to be sorted into descending sequence on their means
9-20	Alphanumeric name
Predictor #2:	
22-24	Variable number
26	Type M or F
28-39	Name
Predictor #3:	
41-43	Variable number
45	Type M or F
47-58	Name

continued

Predictor #4:

60–62	Variable number
64	Type M or F
66–77	Name

If more than four predictors, go on to a second card. Column 1 must be punched 4, then repeat above.

Sample Predictor-List Card

(for 2 predictors)	cc	1	3–5	7	9	22–24	26	28
		4	002	F	POLYARCHY	003	F	ELISIST

Variable-Format Card(s)

FORTRAN-type format. All data fields must be integer (I) mode except identifier fields, which may be A format.

Example. Data cards are punched

	Variable	*Column*
	1	5
	2	6
	3	7
	4	8
	5	9–12
	6	13–14
(Identifier)	7	15–80

Format card would read (A1, 3X, 4I1, I4, I2, 60X, A6)

Note: The A1 must be included (program requirements). Remember that *data* must not be punched in Col. 1. Also remember that the identifier field is included in the number of variables.

Description of Output

Starred paragraphs in the following indicate that this is included in the abbreviated printout when Col. 5 of the main-parameter card is punched—

For each analysis:

* 1. An identifying label

continued

* 2. Number of input observations, number of input variables, number of predictors, index of the variable used as a weight, group split-eligibility criterion, group split-reducibility criterion, minimum group size, maximum number of allowable groups, index and name of the dependent variable, a definition of missing-data values of the dependent variable that were used in deleting such observations, decimal-point locators (scale factors), location of input data, and a definition of which subset, if any, of the input observations were specified for use in the analysis

* 3. A listing of all of the predictors used in the analysis, their maximum values, and the type of predictor (free or monotonic)

* 4. Statistics for the total number of observations in the analysis, including total read, total deleted, total used, and, for the latter, the total sum of weights, sum and sum of squares of the dependent variable, its mean and standard deviation, the total sum of squares (TSS) for the analysis, and the two values PA and PB—i.e., the sum of squares that must be contained in a group if it is to be split and the sum of squares that must be transferred from within- to between-group sums of squares for a split to take place

5. a. A record of the statistics for all attempted partitions of the entire sample (group 1), over all classes of all predictors

   b. These statistics include, for each class, the number of observations, the sum of the weights, ΣY, ΣY^2, $\bar{Y}$, σ, and the BSS_{ikp} for each possible partition between adjacent classes, and the total sum of squares in the group under attempted partitioning

Final output for each analysis consists of:

* 1. A complete definition of each group created during the partitioning process , including the group identification number, the identification of the parent group from which it was split, identification of the variable used to split off this group, the classes of the partitioning variable forming the group, and an indication whether the group was retained as a final group; for the group, the statistics, N, Σw, $\bar{Y}$, ΣY, σ, ΣY^2, deviation of the group mean from the grand mean, weighted proportion of the total observations used that are in the group, weighted mean square for the group, the proportion of the total sum of squares in the group, and the sum of squares for the group

continued

* 2. A one-way analysis-of-variance table over the final groups. This should be interpreted with extreme caution, especially when weighted data are used

3. By option, residuals (discrepancies between observed and predicted values of the dependent variable) may be punched or written on tape, or both, for subsequent analysis. Punched output includes identifying information supplied by the user, the observation number, the identification number of the AID final group into which the observation fell, the predicted value for the observation, its actual value on the dependent variable, and the residual score. Scale factors punched on the control cards provide for the desired number of significant digits in the residuals

If Col. 5 is blank or 0, printout of intermediate results, item 5 is partially omitted.

Program Size Limitations

Maximum number of input variables is 100

Maximum number of dependent variables for any one analysis is 1

Maximum number of predictor variables for any one analysis is 36

Maximum allowable number of groups into which the input observations may be split is 63

Range of any predictor $0 \leq V_p \leq 63$

Range that may be legally taken on by the dependent variable before scaling $-99999 \leq V_y \leq 999999$

Range that may be legally taken on by the weight associated with any given observation $0 \leq V_w \leq 9999$

Range that may be legally taken on by any variable used as a sample selector $-99999 \leq V_f \leq 999999$

Maximum number of variable-format cards is 9

Minimum number of observations that must be contained in the i^{th} group if that group is to become a candidate for splitting $2 \leq N_i \leq 999$

Maximum number of input observations:

Storage requirements are such that, for any problem to be entered into AID, the amount of storage per observation (3–8 words) times the number of observations must be less

continued

than 18 000. Maximum sample sizes for all possible numbers of predictors are listed below. Determine which category the problem falls into, based on the number of predictors. The second line gives the maximum sample size.

	Category					
	(a)	(b)	(c)	(d)	(e)	(f)
No. of predictors (NP) in any one analysis	1–6	7–12	13–18	19–24	25–30	30–36
Max. permissible no. of observations in analysis	6666	5000	4000	3333	2857	2500

If a problem is too large, either the number of input observations must be cut down or the number of predictors must be reduced enough to put it into a different category. For instance, a problem with 12 predictors and a given sample size takes up as much space as one with seven predictors and the same sample size, since both fall into category (b).

Job Deck Structure

```
Job card (CM = 77600)
LIBRARY (AID)
LGO.
7-8-9   (EOR card)
     Label card—Type 1 Card
     Main-parameter card—Type 2 Card
     Secondary-parameter card—Type 3 Card
     Predictor-list card(s)—Type 4 Card(s)
     Variable-format card(s)
     DATAFOLLOWS    (punched in Cols. 1–11)
         (Data deck follows here)
     E    (after last card of data deck) punched in Col 1.
          If an observation (or case) requires more than 1 card,
          then blank cards equalling the # of cards/observation
          must follow the E card

          Example 1    Data on 1 card/observation use E card only.
          Example 2    Data on 3 cards/observation use E card.
                       plus 2 blank cards.
6–7–8–9  (EOI card)
```

SAMPLE INPUT

```
             LIBRARY(AID)
             LGO.
             7-8-9( End of Record )

Label        1 POLITICAL SYSTEMS VARIABLES ONLY
Main Para.   2   11C  0049     7
2nd Para.    3     5   000.00001.00010035003   001GENERAL CONF
Predictor    4 002 F POLYARCHY     003 F ELISIST      004 F CENTRIST     005 F PERSON
List Cards   4 006 F TRADITIONAL
Format        (A1,2X,I4,33X,5I1/2X/A3)
             DATAFOLLOWS
              1   83               3111132111231112231321122
Obs. 1       11
             ARG
              2   88               3111132111321131231331112
             12
             ATR
              3   53               3122132121221221231231112
             11
             AST
              4   85               3132132111321131221331112
             12
   .         BLG
   .          5   78               2113223121131123231121122
   .         11
             BRZ
              6 -180               2222211233313313113111212
             11
             BUL
              7   90               3112132111321131231331112
             12
             CAN
              .
              .
              .
             49 -135               2222212233233313233111212
Obs. 49      11
             YUG
E Card       E
2 blank
  cards
             6-7-8-9 (End of Information)
```

SAMPLE OUTPUT

```
** S T F P  NO. =   1          PARENT  GROUP =  1 **
   TRY  ON  VARIABLE   2  OVER GROUP   1 .  RFSULTS  FOLLOW.

   CODE      N    SUM OF WEIGHT       SUM  OF  Y      SUM  Y-SQUARE       MEAN           STD.   DEV.           B  S  S

     3      19   1.90000000E+01   1.10500000E+03   8.82090000E+04   5.81578947E+01   3.54998342E+01
                                                                                                        1.03277811E+05
     2      14   1.40000000E+01   1.44000000E+02   1.39454000E+05   1.02857143E+01   9.92733805E+01
                                                                                                        1.41204212E+05
     1      16   1.60000000E+01  -1.22600000E+03   2.62976000E+05  -7.66250000E+01   1.02784286E+02
                                                                                                        4.90628204E+05
 *  FOR  VARIABLE   2 ( POLYARCHY    )   B S S =  1.41204212E+05          RSS/TSS =   .28780
   TRY  ON  VARIABLE   3  OVER GROUP   1 .  RFSULTS  FOLLOW.
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
   CODE      N    SUM OF WEIGHT       SUM  OF  Y      SUM  Y-SQUARE       MEAN           STD.   DEV.           B  S  S

     1      39   3.90000000E+01   1.17400000E+03   2.70138000E+05   3.01025641E+01   7.75915654E+01
                                                                                                        1.67809714E+05
     2      10   1.00000000E+01  -1.15100000E+03   2.20501000E+05  -1.15100000E+02   9.38194543E+01
                                                                                                        4.90628204E+05



   CANDIDATE  GROUPS  ARE  AS  FOLLOWS.
   GROUP         N        TOTAL WEIGHT          SUM OF Y           SUM  Y-SQUARE          T  S  S
      2         39      3.90000000E+01       1.17400000E+03       2.70138000E+05      2.34797590E+05
      3         10      1.00000000E+01      -1.15100000E+03       2.20501000E+05      8.80209000E+04
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
                           *  (A)UTOMATIC  (I)NTERACTION  (D)ETECTOR    (MODEL   2)  *
                                      *  *  *  S  U  M  M  A  R  Y  *  *  *

   DFPENDENT VARIAHLE   1  ( GENERAL CONF)

   WEIGHTED  HY  VARIAHLE    0


 ** TOTAL  GROUP

         N  =            49          MFAN = 4.69387755F-01          SUM Y = 2.30000000E+01          TSS = 4.90628204E+05
 TOTAL WT SUM=           49       STD. DFV. = 1.00064082F+02     SUM Y SQ. = 4.90639000F+05


 *   GROUP  NO.   2  SPLIT  FROM  GROUP   1  ON  VARIAHLE     4 (CENTRIST     )
     VALUES  OF  PREDICTOR  INCLUDED  ARE    1
         N  =            39             MFAN = 3.01025641F+01     GROUP DEVIATION = 2.963317631F+01       SUM Y = 1.17400000E+03
  WEIGHT SUM =           39         STD. DFV. = 7.75915654F+01              TSS(I) = 2.34797590F+05   SUM Y SQ. = 2.70138000E+05
 PCT OF TOTAL =    79.6        WTD. MEAN SQ. = 3.53404103F+04     (TSS(I)/TSS(T)) = 4.78565210F-01
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
                            .          .          .          .          .          .          .
```

continued

```
*   GROUP  NO.  26  SPLIT  FROM  GROUP  17  ON  VARIABLE    2 (POLYARCHY   )
    VALUES  OF  PREDICTOR  INCLUDED  ARE    2
 ***  THIS  GROUP  IS  RETAINED  AS  ONE  OF  FINALS.
          N  =              2              MEAN =-1.45000000F+02        GROUP DEVIATION =-1.45469388E+02        SUM Y =-2.90000000E+02
  WEIGHT SUM =              2         STD. DEV. = 3.60000000F+01                  TSS(I) = 2.59200000E+03   SUM Y SQ. = 4.46420000E+04
PCT OF TOTAL =      4.1         WTD. MEAN SQ. = 4.20500000F+04        (TSS(I)/TSS(T)) = 5.28302282F-03

*   GROUP  NO.  27  SPLIT  FROM  GROUP  17  ON  VARIABLE    2 (POLYARCHY   )
    VALUES  OF  PREDICTOR  INCLUDED  ARE    1
 ***  THIS  GROUP  IS  RETAINED  AS  ONE  OF  FINALS.
          N  =              1              MEAN =-1.54000000F+02        GROUP DEVIATION =-1.54469388F+02        SUM Y =-1.54000000E+02
  WEIGHT SUM =              1         STD. DEV. = 0.                              TSS(I) = 0.               SUM Y SQ. = 2.37160000E+04
PCT OF TOTAL =      2.0         WTD. MEAN SQ. = 2.37160000F+04        (TSS(I)/TSS(T)) = 0.



                    * * *    ANALYSIS  OF  VARIANCE  TABLE    * * *

    SOURCE OF            SUM  OF               DEGREE OF         MEAN
     VARIATION           SQUARES                FREEDOM          SQUARE              F

     T O T A L        4.90628204E+05               48

     BETWEEN          3.95348362F+05               13        3.04114140F+04      1.11713002F+01

     WITHIN           9.52798218F+04               35        2.72228062F+03



      RESIDUALS  ARE  NOT  REQUESTED.



                         * * *     E  N  D     * * *
TIME IS NOW   13.31.02.  (HRS-MIN-SEC)

LAST GROUP OF DATA HAS BEEN READ AND PROCESSED
AID IS TERMINATED
```

COST ESTIMATE

The job listed consisted of 49 data, decomposed into 27 groups in 14 steps. The total central-processor time used was 3.712 seconds; peripheral-processor time was 42.660 seconds with a memory useage of 77,600 words. The Northwestern computer charge was $1.74.

Charge to user = computer time + postage and handling + network overhead

= $1.74 + $15.00 + network overhead

= $16.74 + network overhead

CONTENTS—AID

pages

pages	
1,2	Identification & Abstract
3–11	User Instructions
12,13	I/O
15	Cost—Contents

DESCRIPTIVE TITLE	Generalized Stepwise Regression
CALLING NAME	B34T NUCC111
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	This program is a single-precision version of the UCLA BIMED 34, rewritten by Hodson Thornber, The University of Chicago, in FORTRAN II and converted for the CDC 6400 by Donald Morrison, Northwestern University.
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

B34T calculates multiple linear regression in a stepwise manner, inserting at each step that variable which is eligible and has the highest partial correlation with the dependent variable, given that the previously selected variables are in the equation. The eligibility of a variable to be entered is specified by the use of Order Cards and Forcing Mode Cards. The latter, if present, delineate a set of variables to be forced in, a set to be forced out, and a set to be entered stepwise by the partial correlation criterion mentioned above. The order card specifies the order in which a specified set of variables is entered, as follows. B34T forgets completely about variables forced out. It then enters all variables listed on Order Card(s), holding in the equation those forced in, regardless of how low their partial correlations may become. If any forced-in variables remain after the ordered variables have been entered, they are taken as a group and entered by the correlation criterion. After all ordered and all forced variables are in, any unforced variables are entered stepwise.

continued

REFERENCES

Thornber, H., "Manual for (B34T, 8 Mar. 1966) A Stepwise Regression Program," Northwestern Univ. Rep. 6603, a general algebraic description of the standard regression model (with and without the constant), main features and operations of the program, use of special features of the program, and a macro flow for program logic.

"Writeup for (B34T, 8 Mar. 1966) A Stepwise Regression Program" gives detailed instructions for filling out individual Control Cards. This abbreviated writeup may be used by casual users who wish to perform simple and multiple regressions with an expanded set of transgenerations that includes lagging of the variables.

USER INSTRUCTIONS

Data-Format Options

1. Problems may be stacked and, within each main problem, subproblems may be stacked
2. Weighted regressions may be computed (see page 17 of Ref. 1 for description)
3. Lagging can be performed either as a simple transgeneration or in the linear sequential process (see item 5)
4. The regression may be forced through the origin instead of the mean
5. A subroutine is included to compute moving averages and autoregressive series or a sum of the two from any variable in the input data (called *linear sequential process)*
6. After completion of any subproblem, new data, called *extrapolation data,* may be read in and the residuals of these data computed, using the regression coefficients estimated in the subproblem that it follows
7. This program includes options to smooth the data (generalized least squares)
8. New transgenerations may be written by the user if desired

Description of Input Data

Main-Problem Card (required)

Note: All columns indicated below in parentheses can be ignored (left blank) by "casual" users.

Columns	*Contents*
1	$
2–4	Problem number. (If blank, B34T numbers them sequentially)
7–11	Number of observations
12–13	Number of original variables (p)
14–16	Number of variables added in transgeneration (q) (q may be negative, but $p + q \leq 70$)
(17–18)	Index of variable to be used as weight if this is a weighted regression

continued

Columns	*Contents*
(19)	=1: perform all transgenerations and linear processes specified in the previous main problem
(20)	=0: allows new card to be added to previously recorded sets of subproblem cards but does not use any previously recorded cards
	=1: records all the specific subproblem Control Cards following this main problem for use in later main problems. (See Col. 20 of the subproblem card) All previously recorded cards are erased by this option
	=2: uses all previously recorded subproblem cards on this main problem. Any newly specified subproblems will be performed and recorded at the end
(21)	=1: forces regression through the origin
	=2: computes constant by adding a column of ones to the data matrix after transformation
22–23	Number of initial observations to be deleted for lagged variables

Output Parameters

Columns	*Contents*
29	blank: gives first five good transgenerated observations
	=2: gives raw data
	=3: gives transformed data
	=4: gives both
(30)	blank: gives both covariance and correlation matrices
	=2: deletes covariance matrix
	=3: deletes correlation matrix
	=4: deletes both covariance and correlation matrices
31	=2 if residuals or residual statistics are wanted in any following subproblem. (This column is used in conjunction with Cols. 9–10 of the Subproblem Card.)
(32)	=1: punches sums and raw crossproducts after trangeneration in format (6E13.5) and prints card with number of variables, number of observations, and heading that has been read in on Main-Problem Card.

continued

Columns	*Contents*
	=2: punches the transformed data in format (I6, I2, 6E12.5). (I6 is observation number, I2 the card number)
	=3: punches both crossproducts and transformed data

Input Parameters (for input other than BCD cards)

Columns	*Contents*
(33–34)	Logical number of data tape, if any
(35)	blank: reads from the above tape without rewinding
	=1: rewinds before reading
(36)	blank: reads from above tape in binary
	=1: reads in BCD according to the Variable-Format Card
(37)	=1: reads crossproducts produced on earlier run of this program. *Note:* Blank Variable-Format Card (variable format in Cols. 1–2, blanks in Cols. 3–72) is required before crossproduct Header Card
40–69	Alphanumeric description of the problem

Variable-Name Card(s) (optional)

Columns	*Contents*
1– 2	Variable name
5– 6	Index number of first variable named
7–12	Name of first variable
15–16	Index number of second variable named
. . . .	Names may continue to Col. 72. Index numbers can appear in any order. If more cards are needed, simply follow the format of the first Variable-Name Card exactly.

Variable-Format Card(s) (required)

Note: The maximum number of format cards allowed is 10. There must be one and only one variable F format in every main problem. (All but the last format card are Variable-Format Cards.) B34T accepts E- and F-type formats. The Variable-Format Card must appear immediately before the data.

continued

Columns	*Contents*
1– 2	Variable F format (last format card only) Variable E format (all *but* last format card)
3–72	Format statement enclosed in a single set of parentheses

Transgeneration Card(s) (optional)

Columns	*Contents*
1– 2	TG
3– 4	Variable number to be assigned to this variable after the operation has taken place (CVBL)
5– 6	Transgeneration code (see below)
7– 8	Variable number of A variable (AVBL) (index number of first variable used)
9–16	Constant (c) or index number of second variable (BVBL)
(17–18)	Number of the Transgeneration Card that this one replaces from previous problem (may be used only if Col. 19 of Main-Problem Card = 1)

Transgeneration Codes

01	square root (AVBL)	(CVBL)	02	ln (AVBL)	(CVBL)
03	$\log_{10}$ (AVBL)	(CVBL)	04	exp (AVBL)	(CVBL)
05	(AVBL)** (BVBL)	(CVBL)	06	const** (AVBL)	(CVBL)
07	1/ (AVBL)	(CVBL)	08	(AVBL) + const	(CVBL)
09	(AVBL) * const	(CVBL)	10	(AVBL)** const	(CVBL)
11	(AVBL) + (BVBL)	(CVBL)	12	(AVBL)–(BVBL)	(CVBL)
13	(AVBL) * (BVBL)	(CVBL)	14	(AVBL)/(BVBL)	(CVBL)
15	(AVBL) $\le$ const: 1 (AVBL) $>$ const: 0	(CVBL) (CVBL)	16	(AVBL) $\ge$ (BVBL): 1 (AVBL) $<$ (BVBL): 0	(CVBL) (CVBL)
17	$\sin^{-1}$ (AVBL)	(CVBL)	20	sin (AVBL)	(CVBL)
21	cos (AVBL)	(CVBL)	22	lag (AVBL)	(CVBL)

A significant amount of time may be saved by grouping together as much as possible transgenerations with code 22.

The maximum number of allowed transgenerations (excluding code 22) is 120. The maximum number of transgenerations with code 22 is 70.

continued

Note: If Transgeneration Code 22 is used, it will be necessary for the user to delete the proper number of observations. The original number of observations minus the number of observations deleted (Cols. 22–23 of the Main-Problem Card) will be the effective sample size. This effective sample size will be used in *all* subproblems.

Sample transgeneration:

To take $\log_{10}$ of variable 1 and place it in variable 6
TG060301

Subproblem Card (required)

Columns	*Contents*
1	$
2– 4	Subproblem number (If blank, B34T numbers them sequentially)
5– 6	Index number of dependent variable

Output Parameters

Columns	*Contents*
7	=0: gives analysis of variance (ANOVA) after last step only
	=2: ANOVA after the controls are all in (or as controls go in if Col. 23 = 2)
	=3: ANOVA after every step
(8)	=1: deletes covariance matrix of regression coefficients
	=2: punches the upper diagonal of a symmetrical matrix in (GE13.5) format, column by column
9	=2: residuals listed at end of subproblem
	=3: residuals listed after each step
	=4: residuals listed after controls are in
	=5: lists residuals of extrapolation data only and does not require Col. 31 = 2 on Main-Problem Card
Note:	The last two options give residuals at the end of the subproblem only

continued

Columns	*Contents*
10	(Can be used only if Col. 9 is not blank) Summary statistics are always printed if Col. 9 is not blank. Whatever is punched here must be consistent with the punches in Col. 31 of the Main-Problem Card *and* Col. 9 of this card.) blank: lists and plots residuals =1: punches residuals =2: suppresses list of residuals =3: punches summary
(11–12)	Number of terms wanted in autocorrelation function of residuals (limit: 30)
(13)	=1: punches constant and coefficients after last step
(14–16)	Number of observations in extrapolation data (if any)
(17)	Controls output of extrapolation data (see Col. 29 of the Main-Problem Card)

Operating Parameters

Columns	*Contents*
(20)	=1: records the Control Cards for this subproblem
21–22	Standard forcing mode, to be used in conjunction with Forcing-Mode Card. The following option are possible: =-1: to delete all variables not mentioned on a Forcing-Mode Card blank: all unmentioned variables will enter if they attain significance =+1: to force all variables in that are not mentioned on a Forcing-Mode Card (See *Writeup*[2] for the present F values)
(23)	=2: puts ordered and forced variables in after normal termination of the subproblem
(24)	Maximum order of residual-difference equation for smoothing data (limit: 9)
(25–30)	Convergence tolerance for smoothing data (E6.3 format)
(41–42)	Maximum number of steps to be allowed in the regression (E6.3 format)

continued

Columns	*Contents*
(43–48)	Minimum F level for inclusion (blank = .01) (E6.3 format)
(49–54)	Minimum F level for variables in the equation before they will be thrown out (blank = .005) (E6.3 format)
(55–60)	Value of s (blank = .00001) (Those variables in the equation with diagonal element less than s and those variables in the equation with diagonal greater than 1/s are deleted.)

Order Card(s) (optional)

Columns	*Contents*
1– 2	OC
3– 4	Index number of first variable to be entered into the regression. This may be a forced variable. If it is not, it is free to be deleted should its F level fall below F out.
Note:	F-out level is determined by the operating parameters punched on control cards.
5– 6	Index number of second variable to be entered
⋮	⋮
61–62	Index number of 30th variable, if any

Blank fields, set of 2 columns, on this card are ignored. If more than 62 columns are needed, continue on second card as on first.

Forcing-Mode Card(s) (optional)

Columns	*Contents*
1– 2	FM
4	Control character for first variable (-, ,+)

This card uses 4 columns per variable and the control character must be in the second of these 4 columns. Thus, the first of each group of 4 columns is always blank.

The control characters are

minus sign (-) to exclude variables
blank ( ) to let significant variables in if they are selected by the program
plus sign (+) to include variables

continued

Columns	*Contents*
5– 6	Index number of first variable
8	Control character for the second variable
9–10	Index number of second variable
⋮	⋮
60	Control character for 15th variable, if any
61–62	Index number of 15th variable, if any

The variables may be in any order. Blank fields (sets of 4 columns) on this card are ignored. If more than 62 columns are needed, continue on second card exactly as on first.

Finish Card

Columns	*Contents*
1– 6	$$$$$$

Notes:

1. If more than one is required of any Control Card, it is necessary to include the identification letters in Cols. 1–2 of *each* card
2. On Control Cards, all numbers read in I format must be punched right-justified in the columns specified. All numbers read in F format should be punched with decimal points
3. A blank is equivalent to a zero, except in Cols. 5–6 of the Main-Problem Card
4. The format for Comment Cards should be a C in Col. 1, blank in Col. 2, and the comment in Cols. 3–72
5. The limit on the *number of variables* is 70.

Description of Output

Printout is dependent on output parameters set on Main-Problem and Subproblem Cards. It may include transgenerated observations on raw- or transformed-data covariance and correlation matrices, residuals or residual statistics, punched sums, raw crossproducts after transgenerations, and analyses of variance.

Possible output also includes a table of residuals, an autocorrelation of residuals, a plot of residuals, transformed and/or raw data, the Von Neumann ratio and Durbin–Watson statistic, and a full set of regression statistics either at the end of each step or at the end of each subproblem.

continued

Limitations

Up to 99999 cases, 70 variables.

Job Deck Structure

Job Card
LIBRARY (B34T)
LGO.
7–8–9 (EOR Card)

Main-Problem Card	(required)		Repeat for additional (main) problems
Comment Card(s)	(optional)		
Variable-Name Card(s)	(optional)		
Transgeneration Card(s)	(optional)		
Variable-Format Card	(required)		
Data Deck			
Subproblem Card	(required)	Repeat for every subproblem	
(Any of the following option cards can be used before another Subproblem or Main-Problem Card)			
Comment Card(s)	(optional)		
Order Card(s)	(optional)		
Forcing-Mode Card(s)	(optional)		
Finish Card m	(required)		

6–7–8–9 (EOI Card)

REFERENCES

"Writeup for (B34T, 8 Mar. 1966) A Stepwise Regression Program" gives detailed instructions for filling out individual Control Cards. This abbreviated writeup may be used by casual users who wish to perform simple and multiple regressions with an expanded set of transgenerations that includes lagging of the variables.

SAMPLE INPUT

```
VLORR.CM             .CM66500.   B34T
LIBRARY(B34T)
LGO.
$        30 7  0   11        422       1 (B34T, 8 MAR 66) ILLUSTRATIONS
C   DATA WERE GENERATED USING
C   PARAMETER VALUES... B0 = 3.0, B1 = 2.0, B2 = 1.0, RO = .90
C   BASE WEIGHT FOR HETEROSKEDASTICITY = 10.0
VN  01WEIGHT  02  X(1)  03X2)**2  04  Y(1)  05  Y(2)  06  Y(3)  07  Y(4)
TG031303      03
VF(8X6E12.5)
     1 1 0.82645E-02-0.11599E 01-0.11771E-00 0.87588E 00-0.15944E 01 0.24769E-00
     1 2 0.13944E 01 0.10000E 01
     2 1 0.69444E-02 0.15024E-00 0.83199E 00 0.53297E 01 0.11657E 01 0.29687E 01
     2 2 0.39237E 01 0.10000E 01
     3 1 0.59172E-02 0.12075E-00-0.60991E 00 0.42781E 01 0.80352E 00 0.43071E 01
     3 2 0.43444E 01 0.10000E 01
     4 1 0.51020E-02-0.54279E 00 0.15264E 01 0.35157E 01-0.33486E 01 0.25434E 01
     4 2 0.26026E 01 0.10000E 01
     5 1 0.44444E-02 0.59915E 00-0.15482E-00 0.59534E 01 0.17819E 01 0.38229E 01
     5 2 0.47990E 01 0.10000E 01
     6 1 0.39063E-02 0.68031E-01 0.97518E-01 0.26257E 01 0.11032E 01 0.33824E 01
     6 2 0.34044E 01 0.10000E 01
     7 1 0.34602E-02-0.49409E-00 0.99346E 00 0.31393E 01-0.69195E 00 0.18914E 01
     7 2 0.23002E 01 0.10000E 01
     8 1 0.30864E-02-0.98963E 00-0.43524E-00 0.20004E 01-0.21384E 01-0.72992E-01
     8 2 0.14086E 01 0.10000E 01
     9 1 0.27701E-02-0.19316E-00 0.21337E 01 0.77893E 01-0.31056E-00 0.16506E 01
     9 2 0.23124E 01 0.10000E 01
    10 1 0.25000E-02 0.17241E 01 0.91185E 00 0.77234E 01 0.30292E 01 0.67770E 01
    10 2 0.60838E 01 0.10000E 01
    11 1 0.22676E-02-0.76734E 00-0.16379E 01 0.31473E 01-0.40498E 01 0.28187E 01
    11 2 0.10155E 01 0.10000E 01
                 :           :           :           :           :
    30 1 0.62500E-03 0.44640E-01-0.11693E 01 0.40866E 01-0.35066E-00 0.40330E 01
    30 2 0.33499E 01 0.10000E 01
$   043 2          -1                   1.0   0.9
C   STRAIGHT STEPWISE REGRESSION.
FM  02  03  08
$   053 2          -1                   1.0   0.9
C   STEPWISE REGRESSION ON TWO IRRELEVANT VARIABLES, CONST AND X2)**2.
C   WITH CONST PUT IN FIRST, BUT LEFT FREE TO BE DELETED.
FM  08  02  03
OC08
$   06  2          -1
C  REGULAR REGRESSION ON WEIGHTED DATA
FM +02 +08
$        30 7  0 1 2        22  81    (B34T, 8 MAR 66) WEIGHTED REG.
C   DATA ARE READ FROM SCRATCH TAPE 8.
VF
$   06  2          -1
C   WEIGHTED REGRESSION ON WEIGHTED DATA.
FM +02
$        30 7  0                42  81    (B34T, 8 MAR 66) AUTO REG. DIS
VF
$   07  2          -1 3
C   TRANSFORMING DATA TO ALLOW FOR AUTOREGRESSIVE ERRORS.
FM +02
$$$$$$
```

SAMPLE OUTPUT

```
  PROBLEM NUMBER              1

  NO OF OBSERVATIONS         30
  NO OF VARIABLES (IN DATA)   7
  NO OF VAR ADDED             0
  NO OF VARIABLES (IN PROB)   7

  DATA FORMAT USED
     (8X6E12.5)

TG NO.     NO. ASSIGNED     TG CODE     A-VARIABLE     B-VAR. OR CONSTANT

  1             3             13            3             3.00E+00

THE REGRESSION WILL BE FORCED THROUGH THE ORIGIN IN EACH OF THE FOLLOWING SUBPROBLEMS.



STEPWISE REGRESSION - NORTHWESTERN U - (B34T,  8 JAN 68)   (B34T, 8 MAR 66) ILLUSTRATIONS          PAGE

RAW    1   8.265E-03 -1,160E+00 -1.177E-01  8.759E-01 -1,594E+00  2.477E-01  1,394E+00

TRA    1   8.265E-03 -1.160E+00  1.386E-02  8.759E-01 -1.594E+00  2.477E-01  1.394E+00

RAW    2   6.944E-03  1.502E-01  8.320E-01  5.330E+00  1,166E+00  2.969E+00  3,924E+00

TRA    2   6.944E-03  1.502E-01  6.922E-01  5.330E+00  1.166E+00  2.969E+00  3.924E+00

RAW    3   5.917E-03  1,208E-01 -6.099E-01  4.278E+00  8,035E-01  4.307F+00  4,344E+00

TRA    3   5.917E-03  1,208E-01  3.720E-01  4.278E+00  8.035E-01  4.307E+00  4,344E+00
                          :          :          :          :          :
RAW   29   6.575E-04 -5,889E-01 -1.294E-02  3.040E-01 -6.931E-01  2.061E+00  2.393E+00

TRA   29   6.575E-04 -5,889E-01  1.675E-04  3.040E-01 -6,931E-01  2.061E+00  2,393E+00

RAW   30   6.250E-04  4.464E-02 -1.169E+00  4.087E+00 -3.507E-01  4.033E+00  3.350E+00

TRA   30   6.250E-04  4.464E-02  1.367E+00  4.087E+00 -3,507E-01  4.033E+00  3,350E+00
```

continued

```
STEPWISE REGRESSION - NORTHWESTERN U - (B34T,  8 JAN 68)   (B34T, 8 MAR 66) ILLUSTRATIONS          PAGE   3
 VARIABLE          MEAN           STANDARD DEVIATION           VARIANCE

WEIGHT  1      2.349208E-03          2.000609E-03            4.002437E-06

  X(1)  2     -2.482814E-01          8.648010E-01            7.478808E-01

X2)**2  3      1.069850E+00          1.644505E+00            2.704397E+00

  Y(1)  4      3.682356E+00          2.878847E+00            8.287763E+00

  Y(2)  5     -5.007170E-01          2.033591E+00            4.135491E+00

  Y(3)  6      2.427149E+00          2.024985E+00            4.100566E+00

  Y(4)  7      3.199963E+00          1.785360E+00            3.187511E+00
```

```
STEPWISE REGRESSION - NORTHWESTERN U - (B34T,  8 JAN 68)   (B34T, 8 MAR 66) ILLUSTRATIONS          PAGE   4
 CORRELATION MATRIX

                     1
  X(1)  VAR  2  3.23438E-02

                     1             2
X2)**2  VAR  3 -7.66990E-02   2.1[illegible]12E-01

                     1             2             3
  Y(1)  VAR  4  6.25567E-02   7.89791E-01   6.99574E-01

                     1             2             3             4
  Y(2)  VAR  5  6.19875E-02   8.66039E-01   1.17344E-01   6.80035E-01

                     1             2             3             4             5
  Y(3)  VAR  6  4.31374E-02   7.88824E-01   1.34051E-01   6.03780E-01   6.17393E-01

                     1             2             3             4             5             6
  Y(4)  VAR  7 -2.84795E-02   9.55683E-01   1.80919E-01   7.39425E-01   8.44013E-01   7.30512E-01
```

continued

000 0017

000 0017

```
STEPWISE REGRESSION - NORTHWESTERN U - (B34T.  8 JAN 68)   (B34T. 8 MAR 66) ILLUSTRATIONS          PAGE   5
 COMMENT        STRAIGHT STEPWISE REGRESSION.

***************

  PROBLEM NUMBER          1
  SUBPROBLEM NUMBER       1
  F TO ENTER       1.00000             -0.00000
  F TO REMOVE       .90000             -0.00000
  TOLERENCE         .00001
  MAXIMUM NO OF STEPS   2
  DEPENDENT VARIABLE    4          Y(1)

  THE FOLLOWING VARIABLES ARE DELETED IN THIS SUBPROBLEM

  1   5   6   7

 STANDARD ERROR OF Y =  2.8788E+00, FOR DEGREES OF FREEDOM =    29
```

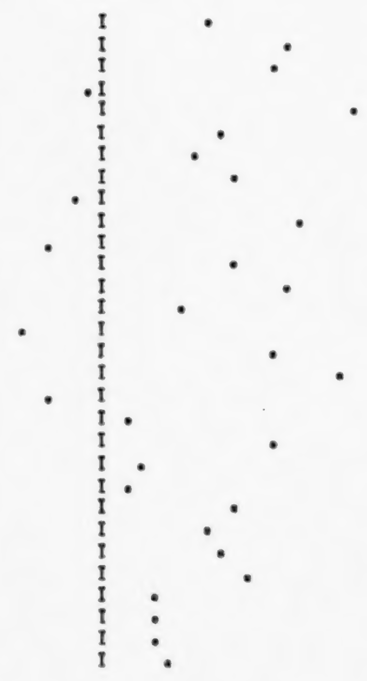
continued

000 0017

```
.............

STEP NUMBER  1                              ANALYSIS OF VARIANCE FOR REDUCTION IN SS DUE TO VARIABLE ENTERING
  VARIABLE ENTERING        3                    SOURCE            DF        SS              MS              F
  MULTIPLE R                .03005            DUE REGRESSION       1      4.07009E+02     4.07009E+02     4.91541E+01
  STD ERROR OF Y.X         2.87755            DEV. FROM REG.      29      2.40128E+02     8.28028E+00
  R SQUARE                  .00090            TOTAL               30      6.47137E+02     2.15712E+01

    MULTIPLE REGRESSION EQUATION
 VARIABLE     COEFFICIENT   STD. ERROR    T VALUE     PARTIAL COR.   ELASTICITY              PARTIAL COR. FOR VAR. NOT IN EQUATION
  Y(1) =                                                                                 VARIABLE     COEFFICIENT    F FOR SELECTION
X2)**2   X- 3   1.8998E+00   2.7098E-01   7.0110E+00   7.9306E-01   5.5197E-01   *        X(1)  X- 2   3.6653E-01   4.3453E+00


.............

STEP NUMBER  2                              ANALYSIS OF VARIANCE FOR REDUCTION IN SS DUE TO VARIABLE ENTERING
  VARIABLE ENTERING        2                    SOURCE            DF        SS              MS              F
  MULTIPLE R                .36759            DUE REGRESSION       2      4.39269E+02     2.19634E+02     2.95848E+01
  STD ERROR OF Y.X         2.72468            DEV. FROM REG.      28      2.07869E+02     7.42389E+00
  R SQUARE                  .13512            TOTAL               30      6.47137E+02     2.15712E+01

    MULTIPLE REGRESSION EQUATION
 VARIABLE     COEFFICIENT   STD. ERROR    T VALUE     PARTIAL COR.   ELASTICITY              PARTIAL COR. FOR VAR. NOT IN EQUATION
  Y(1) =                                                                                 VARIABLE     COEFFICIENT    F FOR SELECTION
  X(1)   X- 2   1.1710E+00   5.6173E-01   2.0845E+00   3.6653E-01  -7.8951E-02
X2)**2   X- 3   1.8887E+00   2.5664E-01   7.3592E+00   8.1191E-01   5.4872E-01

 RESIDUAL VARIANCE =     7.4239E+00

 ORDER OF ENTRANCE (OR DELETION) OF THE VARIABLES =    3    2

ESTIMATE OF COMPUTATIONAL ERROR IN COEFFICIENTS =
    1   1.674E-14     2   2.712E-14

  COVARIANCE MATRIX OF REGRESSION COEFFICIENTS

ROW  1   VARIABLE X- 2      X(1)
       3.15540E-01

ROW  2   VARIABLE X- 3    X2)**2
      -3.01188E-03    6.58639E-02

*** PROGRAM TERMINATED - ALL VARIABLES PUT IN
```

continued

```
                    TABLE OF RESIDUALS

OBSERVATION     Y VALUE         Y ESTIMATE       RESIDUAL
     1        8.758800E-01    -1.332017E+00    2.207897E+00
     2        5.329700E+00     1.483265E+00    3.846435E+00
     3        4.278100E+00     8.439537E-01    3.434146E+00
     4        3.515700E+00     3.764793E+00   -2.490929E-01
     5        5.953400E+00     7.468447E-01    5.206555E+00
     6        2.625700E+00     9.762160E-02    2.528078E+00
     7        3.139300E+00     1.285478E+00    1.853822E+00
     8        2.000400E+00    -8.010325E-01    2.801432E+00
     9        7.789300E+00     8.372256E+00   -5.829560E-01
    10        7.723400E+00     3.589197E+00    4.134203E+00
    11        3.147300E+00     4.168210E+00   -1.020910E+00
    12        2.238900E+00    -3.500618E-01    2.588962E+00
    13        3.461700E+00    -4.423388E-01    3.904039E+00
    14        1.329900E+00    -4.163232E-01    1.746223E+00
    15        7.050500E+00     8.797619E+00   -1.747119E+00
    16        6.057100E+00     2.601470E+00    3.455630E+00
    17        5.461000E+00     4.496052E-01    5.011395E+00
    18        1.274500E+01     1.374550E+01   -1.000499E+00
    19        1.984400E+00     1.518204E+00    4.661956E-01
    20        3.388800E+00    -2.871453E-01    3.675945E+00
    21       -2.955700E-01    -1.087145E+00    7.915750E-01
    22        5.303800E+00     4.728194E+00    5.756064E-01
    23        3.164000E+00     5.670412E-01    2.596959E+00
    24        2.908300E+00     6.365508E-01    2.271749E+00
    25        3.572300E+00     1.041534E+00    2.530766E+00
    26        3.175200E+00     2.621689E-01    2.913031E+00
    27       -1.007700E+00    -2.163694E+00    1.155994E+00
    28       -8.357400E-01    -1.869475E+00    1.033735E+00
    29        3.040100E-01    -6.892564E-01    9.932664E-01
    30        4.086600E+00     2.634559E+00    1.452041E+00

VON NEUMANN RATIO......    1.19829          DURBIN-WATSON TEST.....    1.15835

AUTOCORRELATION FUNCTION OF RESIDUALS

    1)   .4180      2)   .3929      3)   .6821      4)   .6315

     :          :          :          :          :
     .          .          .          .          .
```



COST ESTIMATE

For the job listed on the Sample Input, the total running time was 2.659 seconds for central-processor time and 43.005 seconds for peripheral-processor time with a memory useage of 66,500 words. Chargeable computer time was $1.60.

Charge to user = computer time + postage and handling + network overhead
= $1.60 + $15.00 + network overhead
= $16.60 + network overhead

CONTENTS—B34T

pages
1,2 Identification & Abstract
3–11 User Instructions
13–18 I/O
19 Cost—Contents

DESCRIPTIVE TITLE	Biserial—Point-Biserial Correlation Program
CALLING NAME	BISR NUCC117
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	N. John Castellan, Jr. Vogelback Computing Center Stephen W. Link Vogelback Computing Center
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

BISR has been designed to compute either biserial or point-biserial correlation coefficients. At the user's option, the biserial coefficients will be computed, assuming that a particular discrete item constitutes a subscore for the continuous variable. (This case is analogous to an item-total correlation.) The following data for each discrete variable are obtained from this analysis.

(a) means of continuous variables for failing groups

(b) means of continuous variables for passing groups

(c) means for the continuous variables

(d) proportion of cases in the passing group

(e) standard deviation of continuous variables for those cases with a pass or fail response on the associated discrete variable

(f) correlation coefficients

continued

Computational Procedure

Formulas Used:

$$r_b = (M_2 - M_1)\ P_1\ \ P_2/z\ s_y,$$

$$r_{pb} = [(M_2 - M_y)/s_y]\ (P_2/P_1)^{\frac{1}{2}}.$$

If $r_b{}^1$ is to represent an item-total correlation,

$$r_b{}^1 = [r_b\ s_y - (P_1\ P_2\ /z)]/\ (s_y{}^2 + P_1\ P_2 - 2r_b\ s_y\ z)^{\frac{1}{2}},$$

where P_1 is the proportion of cases in the failing group (0's) and P_2 is the proportion of cases in the passing group (1's or 2's); M_1 and M_2 are the means of the continuous variable for failing and passing groups, respectively, and M_y is the mean for the continuous variable; s_y is the standard deviation for the continuous variable for those cases with a pass or fail response on the associated discrete variable; and z is the ordinate of the unit normal curve at the point where P_1 (or P_2) cases are cut off.

$$s_y{}^2 = [N\ \Sigma\ X^2 - (\Sigma\ X)^2]/\ N(N - 1)\ .$$

REFERENCES

Castellan, N. J., Jr., and Link, S. W., " Biserial Point-Biserial Correlation Program for IBM 709/7090," Behavioral Sci. *8*, 368–369 (Oct. 1963).

Henrysson, S., "Correction of Item-Total Correlations in Item Analysis," Psychometrika *28*, 211–218 (1963).

USER INSTRUCTIONS

Description of Input Data

The continuous variables may be of any magnitude and the range of magnitude may vary from variable to variable. The discrete variable may take on values of 0 and 1 with digits 2, ···, or 9 as an index for missing data or 0 and 2 with 1 as an index for missing data. However, these values may not change for a given problem. A continuous variable may not take on values less than zero.

Heading Card

Columns	
1– 6	Problem number, which is an alphanumeric title for the particular problem, e.g., DECK27
7– 9	The number of continuous variables (NC), e.g., 006
10–12	The total number of discrete variables (ND), e.g., 017
13–18	The number of replications (NS). This must be punched as a 6-digit number; e.g., if NS = 627, punch 000627
19	Punch 2 if biserial correlation coefficients are desired Punch 1 if point-biserial correlation coefficients are desired
20	Punch 1 if discrete data are described by 0 and 1 with 2, ···, 9 as an index for missing data Punch 2 if discrete data are described by 0 and 2 with 1 an index for missing data
21	Punch 0 if point-biserial correlation coefficients are desired Punch 1 if no discrete variable is considered part of any continuous variable Punch 2 if some discrete items are considered to be subscores of some continuous variable [in this case, subtest card(s) are required] Punch 3 if all discrete items are considered to be subscores of the associated continuous variables
22	Punch the number of continuous-variable variable-format cards (e.g., if you use one such card, punch 1)
23	Punch the number of discrete-variable variable-format cards
24–72	Must be left blank
73–80	May contain identification as desired

continued

Variable-Format Cards

Each problem deck requires two sets of variable-format cards, one for the continuous variables and the other for the discrete variables.

Continuous-Variables Variable-Format Card(s)

In preparing the variable-format card, the word FORMAT is not used. For example, (12F3.0,F4.0,11F2.0) punched in the first 20 columns of the variable-format card will describe 12 three-column fields (variables) followed by 1 four-column field, followed by 11 two-column fields. The alphabetic letter X (to designate a skipped column) and a solidus (/ to designate "go to next card") could also be used, and one additional level of parentheses may be used to simplify format description. For example (25(F1.0,1X)) will specify the pickup of 25 one-digit fields from alternate Cols. 1, 3, 5, 7,···, 49. This notation may, of course, be combined in any suitable manner.

Discrete-Variables Variable-Format Card(s)

This card is prepared in the same manner as above, except that each discrete variable is indicated by I format rather than F format. *Note:* If it is necessary to use more than 72 columns to describe the format, continue the statements on another card, using as many cards as necessary. Note that for the entire format specification only one left and one right parenthesis is used, except for the simplifying cases described. However, note too that the number of variable-format cards must be indicated in Cols. 22 and 23 of the heading card.

Association Card(s)

These cards are used to indicate the number of discrete variables associated with each continuous variable. Begin in Col. 1 and use successive 3-digit fields to describe the number of discrete variables associated with each successive continuous variable. For example, 003010001003 indicates that the first three discrete variables are associated with the first continuous variable; the next 10 (4th–13th) discrete variables are associated with the second continuous variable; the next (14th) discrete variable is associated with the 3rd continuous variable; the next two (15th and 16th) discrete variables are associated with the 4th continuous variable. One association card will be used for each 24 continuous variables.

continued

Subtest Card(s)

If some of the discrete items are considered to be subscores of some of the continuous variables, then these cards are required. For instance, if discrete items 1–16 constitute the first continuous variable, these subtest card(s) are required.

Columns	
1– 3	The number of discrete items that are subscores
4– 6 7– 9 10–12 : 70–72	The item sequence number of the discrete items that are subscores

If more than 23 discrete items are specified in Cols. 1–3, continue on to another card, punching the sequence numbers into 3-column fields, beginning with Cols. 1–3. For example, in the preceding illustration, the subtest card would read thus.
016001002003004005006007008009010011012013014015016

Note: If *all* discrete variables are subscores, subtest cards are not required.

Data Cards

Data cards must conform to the format designated on the variable-format cards. The last variable must appear in the same location on each card.

The number of cards must be twice the number punched into Cols. 13–18 in the heading card. (If two cards are used for continuous variables, then the number of data cards is equal to 3 NS, etc.) The data cards must be arranged as follows.

Continuous-variable card(s) for Subject 1
Discrete-variable card(s) for Subject 1
Continuous-variable card(s) for Subject 2
Discrete-variable card(s) for Subject 2
. . . . .
. . . . .
. . . . .
Discrete-variable card(s) for last subject

Any number of different consecutive problems may be processed by repeating the preceding steps for each such problem.

continued

After the last problem, A FINISH CARD must be inserted. FINISH is to be punched into Cols. 1–6 of this card.

Description of Output

For each discrete variable, the output consists of the six types of results listed within the abstract.

Error Indications

Error messages will be printed out upon mispunching of the discrete-data code in Col. 20 of the header card, failing to specify the number of variable-format cards, or failing to specify the subtest-total option.

Limitations

The program will compute correlation coefficients on up to 999 continuous and 999 discrete variables. The maximum number of subjects allowed is 999999. Further, any number of problems may be submitted at one time, each of which will be subject to the above restrictions.

Job Deck Structure

```
Job Card
LIBRARY(BISR)
LGO.
7-8-9 EOR
      ┌Heading card
      │Variable-format cards
      │Association cards
      │Subtest cards, if needed
      └Data cards
            (Repeat for as many problems as desired)
       FINISH card (after last problem set only)
6-7-8-9 EOI
```

SAMPLE INPUT

```
VLCRR,[redacted],CMS3400.   BISR
LIBRARY(BISR)
LGO.
DECK2800302400023811311
(8X,3(F4.1,4X))
(24X,2(8I1,4X),7I1,/X,I1)
008V08.08
F0001 2 12.0 10.0  2.5 10          . 0          . 0         1      38
F0001 2 12.0 10.0  2.5 10          . 0          . 0         1      38
F0002 2  8.0  7.0  1.0 21100000000.50000000000.000000000100000130000
F0002 2  8.0  7.0  1.0 21100000000.50000000000.000000000100000130000
F0003 2 10.   7.0  3.0 10000000000.00000000000.000000000100000003000
F0003 2 10.   7.0  3.0 10000000000.00000000000.000000000100000003000
F0004 2 11.0 10.0  1.0 10          . 11        0.50          1      24
F0004 2 11.0 10.0  1.0 10          . 11        0.50          1      24
F0005 2 11.0  8.0  3.0 1111 1    2.00           . 0          1      38
F0005 2 11.0  8.0  3.0 1111 1    2.00           . 0          1      38
F0006 2 11.0 10.0  1.0 10          . 0          . 0         1      12
F0006 2 11.0 10.0  1.0 10          . 0          . 0         1      12
F0007 2 12.0  8.0  4.0 111       3.00           . 0           1       60
F0007 2 12.0  8.0  4.0 111       3.00           . 0           1       60
F0008 2 12.0  4.0  8.0 20          . 0          . 0          1      36
F0008 2 12.0  4.0  8.0 20          . 0          . 0          1      36
F0009 2  9.0  7.0  2.0 20          . 0          . 0         1      26
F0009 2  9.0  7.0  2.0 20          . 0          . 0         1      26
F0010 2 12.0  9.0  3.0 111       1.50           . 0          1       44
F0010 2 12.0  9.0  3.0 111       1.50           . 0          1       44
   .                               .                                  .
   .                               .                                  .
   .                               .                                  .

M 125 1  9.5  5.5  4.0 21 1      3.01 11 1   3.01 1
M 125 1  9.5  5.5  4.0 21 1      3.01 11 1   3.01 1
M 127 1  9.5  8.5  1.0 10          . 0          . 0
M 127 1  9.5  8.5  1.0 10          . 0          . 0
M 128 1  4.0  3.0  1.0 10          . 0          . 0
M 128 1  4.0  3.0  1.0 10          . 0          . 0
M 129 1 18.5 17.5  1.0 10          . 0          . 0
M 129 1 18.5 17.5  1.0 10          . 0          . 0
M 132 1 10.5  9.5  1.0 10          . 0          . 0
M 132 1 10.5  9.5  1.0 10          . 0          . 0
M 133 1  5.5  4.5  1.0 10          . 0          . 0
M 133 1  5.5  4.5  1.0 10          . 0          . 0
M 134 1  7.5  6.5  1.0 10          . 0          . 0
M 134 1  7.5  6.5  1.0 10          . 0          . 0
M 135 1 15.0  4.0  1.0 20          . 11        0.50
M 135 1 15.0  4.0  1.0 20          . 11        0.50
M 136 1 13.5 12.5  1.0 10          . 0          . 0
M 136 1 13.5 12.5  1.0 10          . 0          . 0
M 138 1 12.5 11.5  1.0 10          . 0          . 0
M 138 1 12.5 11.5  1.0 10          . 0          . 0
M 139 1 11.5 10.5  1.0 111       0.50           . 0
M 139 1 11.5 10.5  1.0 111       0.50           . 0
M 140 1 10.0  9.5  0.5 10          . 0          . 0
M 140 1 10.0  9.5  0.5 10          . 0          . 0
M 141 1  3.5  3.0  0.5 10          . 0          . 0
M 141 1  3.5  3.0  0.5 10          . 0          . 0
M 142 1  9.5  9.0  0.5 20          . 0          . 0
M 142 1  9.5  9.0  0.5 20          . 0          . 0
M 144 1 12.0 11.5  0.5 30          . 0          . 0
M 144 1 12.0 11.5  0.5 30          . 0          . 0
FINISH
```

SAMPLE OUTPUT

```
JOB NO. DECK28

    POINT BISERIAL CORRELATION PROGRAM, IBS-003

NUMBER OF SUBJECTS =   238
NUMBER OF CONTINUOUS VARIABLES =  3

 NUMBER OF DISCRETE VARIABLES ASSOCIATED WITH EACH CONTINUOUS VARIABLE.

          8          8          8


 AMOUNT OF MISSING DATA FOR EACH DISCRETE VARIABLE.

          0          0          0          0          0          0          0          0          0          0
          0          0          0          0          0          0          0          0          0          0
          0          0          0         12


DECK28
 TABLE OF MEANS FOR GROUP PASSING.

    10.585     10.632      9.739     10.594     10.000      9.455      9.500     15.500    195.110    171.207
   152.630    333.944    214.686    125.725      0.000      0.000    109.407    110.241    102.307    135.600
   107.333    111.050    101.000    110.250


 TABLE OF MEANS FOR GROUP FAILING.

    11.400     11.301     11.407     11.135     11.200     11.178     11.110     11.085    182.442    137.210
   187.879    178.306    183.422    185.403    184.370    194.370    109.852    106.331    104.731    134.772
   108.800    108.645    108.789    108.714
```

continued

```
TABLE OF STANDARD DEVIATIONS.

     3.581      3.581      3.581      3.581      3.581      3.581      3.581      3.581    241.620    241.620
   241.620    241.620    241.620    241.620    241.620    241.620      3.760      3.760      3.760      3.760
     3.760      3.760      3.760      3.657

DFCK28
 TABLE OF MEANS FOR TOTAL GROUP.

    11.099     11.099     11.099     11.099     11.099     11.099     11.099     11.099    184.370    184.370
   184.370    184.370    184.370    184.370    184.370    184.370    108.700    108.700    108.700    108.700
   108.700    108.700    108.700    108.795

DFCK28
  TABLE OF PROPORTICNS FOR GROUP PASSING.

      .370       .303       .185       .067       .084       .046       .004       .004       .251       .177
      .100       .039       .030       .017      0.000      0.000       .341       .193       .091       .023
      .068       .023       .011       .053

 TABLE OF CORRELATICN COEFFICIENTS.

     -.110      -.086      -.181      -.038      -.093      -.101      -.047       .080       .014      -.025
     -.044       .125       .022      -.032      0.000      0.000      -.056       .201      -.026      -.126
     -.098       .095      -.220       .094

 NOTE-- DATA IN ABOVE TABLES ARE LISTED ROW-WISE BEGINNING WITH VARIABLE 1.
```

000 0018

COST ESTIMATE

For the job listed on the Sample Input, the total running time w 2.494 seconds for central-processor time and 14.615 seconds for peripheral-processor time with a memory useage of 53, 400 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—BISR

pages

1,2	Identification & Abstract
3–6	User Instructions
7–9	I/O
11	Cost—Contents

DESCRIPTIVE TITLE	Canonical Correlation
CALLING NAME	CANON NUCC168
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	University of Miami Biometric Laboratory
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

The program computes canonical correlations between two sets of variables and tests their significance. It also scores each subject, using the weights associated with the canonical correlations. The methods used in these calculations may be found in the references cited below.

REFERENCES

Hotelling, H., "Relations between Two Sets of Variates," Biometrika *28*, 321–377 (1936).

Bartlett, M. S., "The Statistical Significance of Canonical Correlations," Biometrika *32*, 29–37 (1941).

USER INSTRUCTIONS

Preparation of Data

The program expects cards in the following sequence.

Title Card

Columns	*Contents*
1–72	Title to be printed on ouput (any alphanumeric characters)

Problem Card

Columns	*Contents*
1– 5	Number of variables in first set, right-justified (maximum 50)
6–10	Number of variables in second set, right-justified (must not be more than number of variables in first set)
11–15	Number of subjects, right-justified (maximum 2500)
16	Blank: input data located on cards 4: input data located on alternate tape (logical tape 4). Only the Data Cards described below can be on tape 4. The Control Cards (including this one) must still be on *card* input
17	Number of extra Variable-Format Cards (in addition to this card)
37–72	Variable format for one subject (must begin and end with parentheses and include subject identification in A format, followed by his scores in F format)

Variable Format (optional)

Columns	*Contents*
1–72	Continuation of variable format, if needed. Up to nine cards may be used, as specified in Col. 17 of the Problem Card

continued

Variable Names

Columns	*Contents*
1– 6	Name of first variable (any alphanumeric characters)
7–12	Name of second variable, etc.
.	
.	
.	
67–72	Name of 12th variable. Continue on as many additional cards as necessary. The total number of names must equal the number of variables in the first set *plus* the number of variables in the second set

Data Cards

First comes a subject's identification, followed by his score on the first variable, his score on the second variable, etc. *The columns must conform to the variable-format statement.*

(Additional problems may follow, each beginning with a Title Card and ending with Data Cards.)

Finish Card

Columns	*Contents*
1– 6	FINISH

Limitations

1. No more than 50 variables in each set. (If one set includes more variables than the other, it must be the first one.)
2. No more than 2500 subjects
3. The number of subjects must exceed the total number of variables
4. No missing data. If a score is missing (blank or minus zero on the Data Card), it will be detected, and that subject will be omitted from the analysis

continued

Sample Job Deck

```
JOB card
REQUEST(TAPE4)  HANG XXXX (if data are on tape)
LIBRARY(CANON)
LGO.
7-8-9  (EOR card)
Title Card                              ┐
Problem Card                            │
Variable-Format Card (optional)         │  repeat as many times as
Variable-Name Cards                     │  desired
Data deck                               │
                                        ┘
FINISH Card
6-7-8-9  (EOI card)
```

SAMPLE INPUT

```
VLORR,[redacted]-3306,CM61300.    CANON
LIBRARY(CANON)
LGO.
PSYCHOLOGICAL TESTS AND EEG MEASURES
    6     5    43                            (6X, A3, 3X, 11F4.0)
TAP    STEAD CFF   ARITH BLOCK DIG SYDELTA THETA ALPHA BETA 1BETA 2
 1 2    82 1  680   9 306   7   9   7  29  45 127  76  37                FINK
 1 3    83 1  650  14 326   7  12  10  51  63 168  58  45                FINK
 1 1    84 1  650  42 281  15  13  14  38  65 233  59  34                FINK
 1 2    89 1  640  49 359  12   8  10  30  56 119  36  20                FINK
 1 3    91 1  650  40 272   9  12  10  26  34 117  46  29                FINK
 1 1    92 1  770   8 302  16  10  13  26  40  81  41  23                FINK
 1 2    93 1  600  61 311  13  14  14  23  34  82  34  22                FINK
 1 3    94 1  650  20 351   7  10  14  22  36  67  53  27                FINK
 1 1    95 1  703  65 296  15  13  14  17  25  36  28  34                FINK
 1 3    96 1  740  21 310   7  14  11  25  43 103  75  46                FINK
 1 2    97 1  660  23 336  10  16  14  42  79 300 112  59                FINK
 1 3    98 1  720  11 280   9  11  11  58 107 311 124  63                FINK
 1 1    99 1  573  30 332  12  10   7  32  36  24  15  15                FINK
 1 3   101 1  640   6 279   7   7  12  30  46  91  67  38                FINK
 1 2   103 1  810  26 342  18  18  16  28  51  94  32  16                FINK
 1 2   104 1  500  54 302   7  14  16  32  40 115  91  42                FINK
 1 3   106 1  640  22 295  12  10   8  24  54 106  38  20                FINK
 1 1   107 1  670  27 250  15  13  12  28  41  89  41  17                FINK
 1 2   108 1  640  14 199   1   8   3  22  45 230 107  47                FINK
 1 1   112 1  720  10 350  12  16  10  24  40 129  42  22                FINK
 1 2   113 1       20 310   4  10  12  26  31  31  23  11                FINK
 1 3   115 1  810  20 335  13  10   8  16  40 161  45  24                FINK
 1 3   116 1  770  19 263  18  10  11  31  42 110  37  13                FINK
 1 3   117 1  620  52 295  13  10   6  29  43  62  31  13                FINK
 1 2   119 1  310  48 284  16  11  10  38  66 190  75  61                FINK
 1 1   121 1  770  12 311   7   8  11  32  58 155  66  42                FINK
 1 1   124 1  740   6 325  16  14  10  19  41 149  48  26                FINK
 1 1   125 1  740 107 297  13  11   9  22  60  77  58  44                FINK
 1 2   127 1  730  39 346  10  12  13  24  45 213  55  39                FINK
 1 2   128 1  630  50 272  10   5   6  19  33  95  39  24                FINK
 1 1   129 1  690  35 388  10  11   8  39  74 134  29  19                FINK
 1 3   131 1  640  14 340  10  10  12  32  45  99  44  35                FINK
 1 1   132 1  760   7 317  15  14  16  30  50 162  46  23                FINK
 1 3   137 1  730  79 275   6   6   9  15  16  51  24  13                FINK
 1 3   138 1  650  67 288  15  12   9  35  84 107  37  19                FINK
 1 2   139 1  750   9 314   6   8   7  25  42 144  49  24                FINK
 1 2   141 1  710  50 283  10  14  12  23  40  91  37  22                FINK
 1 2   142 1  650  26 282  16  13  14  29  36 130  39  25                FINK
 1 3   143 1  670  24 288  15  12  13  28  31  50  36  22                FINK
 1 3   145 1  610  11 327   7  10  12  41  67 274 110  64                FINK
 1 2   147 1  790   4 265  12  16  14  26  36  80  45  37                FINK
 1 2   149 1  690  34 289   9   9  11  22  40 181  59  30                FINK
 1 2   150 1  580  49 276  15  13   8  33  48 143  53  36                FINK
FINISH
```

SAMPLE OUTPUT

```
VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY

C A N O N - - CANONICAL CORRELATION PROGRAM

                 PSYCHOLOGICAL TESTS AND EEG MEASURES



                  6 VARIABLES IN FIRST SET

                  5 VARIABLES IN SECOND SET


         FORMAT OF DATA CARDS              (6X, A3, 3X, 11F4.0)
                 SUBJECT 113    OMITTED FROM ANALYSIS BECAUSE OF MISSING DATA


                 42 SUBJECTS


                VARIABLE              MEAN        STANDARD DEVIATION

                 TAP                 674.905            88.784
                 STEAD                31.286            22.952
                 CFF                 303.310            34.362
                 ARITH                11.262             3.902
                 BLOCK                11.357             2.827
                 DIG SY               10.833             3.003
                 DELTA                28.929             8.708
                 THETA                48.024            16.856
                 ALPHA               130.476            66.839
                 BETA 1               53.262            24.992
                 BETA 2               31.214            13.957


                                                CORRELATIONS


VARIABLE   TAP    STEAD  CFF    ARITH  BLOCK  DIG SY DELTA  THETA  ALPHA  BETA 1


 STEAD      -.263

 CFF         .127  -.111

 ARITH       .048   .158   .054

 BLOCK       .116  -.059   .184   .449

 DIG SY      .119  -.084   .211   .335   .593

 DELTA      -.287  -.240   .125  -.037   .140   .117

 THETA      -.122  -.082   .169  -.008   .105  -.026   .809

 ALPHA      -.077  -.312   .008  -.241   .069   .013   .567   .676

 BETA 1     -.200  -.275  -.177  -.492   .002   .028   .498   .548   .789

 BETA 2     -.305  -.144  -.087  -.388   .059   .096   .511   .520   .691   .882
```

continued

```
-      LATENT ROOT      CANONICAL        WILKS                          DEGREES OF         P
         NUMBER        CORRELATION       LAMBDA       CHI SQUARE         FREEDOM       LESS THA


           1               .838           .1708         63.616             30            .0003

           2               .516           .5729         20.056             20            .4544

           3               .409           .7809          8.302             12            .7113

           4               .239           .9382          2.297              6            .8915

           5               .071           .9950           .182              2            .9132



STANDARDIZED WEIGHTS ASSOCIATED WITH LATENT ROOT NO. 1


                   FIRST SET                               SECOND SET

              VARIABLE       WEIGHT                   VARIABLE       WEIGHT


               TAP            -.404                    DELTA           .688
               STEAD          -.415                    THETA         -1.038
               CFF            -.429                    ALPHA          -.157
               ARITH          -.748                    BETA 1         1.240
               BLOCK           .156                    BETA 2         -.137
               DIG SY          .414



SUBJECTS SCORED ACCORDING TO WEIGHTS FOR LATENT ROOT NO. 1

                            SUBJECT         SCORE ON FIRST SET    SCORE ON SECON


                              108                 2.476                1.037
                              104                 2.077                2.554
                              101                 1.657                 .022
                              145                 1.269                1.062
                              147                 1.000                 .158
                               94                  .900                 .371
                               98                  .890                1.464
                               83                  .880                 .834
                               96                  .792                1.005
                               97                  .745                1.390
                                .                   .                    .
                                .                   .                    .
                                .                   .                    .
                              143                 -.037                 .392
                               93                 -.043                -.363
                              106                 -.177               -1.353
                              137                 -.301                -.225
                              127                 -.347                -.386
                              112                 -.403                -.364
                              128                 -.519                -.418
                              150                 -.564                 .233
                               99                 -.616                -.521
                               92                 -.680                -.153
                               95                 -.836                -.593
                              124                 -.987                -.607
                              116                -1.051                -.051
                              117                -1.096                -.458
                              103                -1.215               -1.084
                              138                -1.275               -2.374
                               89                -1.299               -1.132
                              129                -1.362               -1.006
                              119                -1.606                -.940
                              125                -2.193               -1.049
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 1.073 seconds for central-processor time and 23.437 seconds for peripheral-processor time with a memory useage of 61,300 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—CANON

pages

1	Identification & Abstract
3–5	User Instructions
7–9	I/O
11	Cost—Contents

DESCRIPTIVE TITLE	χ^2 and C Statistics
CALLING NAME	CHISQR NUCC028
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presentaly available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

CHISQR forms a contingency table from numeric data and calculates χ^2, C, the percentages of samples in the categories, and the percentages of the categories in the samples.

CHISQR reads in *numeric* data for as many as 10 samples, each consisting of as many as 1000 subjects. The range of sample values for all samples can be divided into as many as 10 subsets, called categories; a contingency table is then formed by determining the frequencies with which data from ISMPLS of the samples ($2 < ISMPLS \leq 10$) fall into the categories. χ^2 and C (the contingency coefficient) are printed out, the table is displayed, and the percentages of samples in the categories and categories in the samples are shown. Alternatively, the program will accept input of the actual frequencies and/or expected frequencies instead of calculating them from raw data and frequencies, respectively.

Computational Procedure

χ^2 Test

1. The *relative frequencies* with which m *independent* samples (rows) are classified into n mutually exclusive categories (columns) are calculated and treated as interval measurements. This

continued

implies only that the raw data must have *nominal* (classificatory) measurement. A table of these frequencies is called a *contingency table*.

2. H_0 indicates that there is no difference between the m samples in the proportion of observations that fall into the n categories—i.e., that the rows of frequencies have come from the same or identical populations. H_1 must be two-tailed if $m > 2$, $n > 2$ (i.e., $df > 1$), as explained below.

3. χ^2 is calculated from the contingency table; its sampling distribution is approximated by the chi-squared distribution with $df[=(m-1)*(n-1)]$ degrees of freedom.

The χ^2 test cannot be applied if the expected frequencies are too small. If $df = 1$, a Yates-corrected χ^2 is calculated. Difficulty with small expected frequencies can be avoided by increasing the number of degrees of freedom or by combining "similar" categories (columns) of the contingency table. The χ^2 test is insensitive to the effects of order when $df > 1$.

4. The power efficiency of the χ^2 test is difficult to determine, since it is applied usually to data that cannot be analyzed by any alternative test. However, its limiting power is one as the number of degrees of freedom increases.

Contingency Coefficient

1. The contingency coefficient (C) is computed from the χ^2 contingency table and will have no correlation to the population when H_0 exists (i.e., the value of C arose from chance). When H_1 exists, the samples for C were correlated from a contingency table where $df = [(m-1)*(n-1)] > 1$. This is an indicator that C is significant and accurate.

2. When $C = 0$, there is a complete lack of association between the variables being measured.

3. When $C \neq 1$ $(0 < C < 1)$, there is a complete dependence between the variables.

4. When C approaches 1, the degrees of freedom approach infinity.

5. Two contingency coefficients can not be compared unless they were derived from the *same size tables*. These coefficients are not directly comparable to any other measure of correlation.

USER INSTRUCTIONS

Description of Input Data

Input of Raw Data

Problem Card

Parameter	*Columns*	*Contents*
	1– 6	*INPUT
NSMPLS	7– 8	Number of samples on each deck of cards ($1 \leq \text{NSMPLS} \leq 10$)
NTIMES	9–10	Number of decks
MISDAT	11	= 0 if no missing data are present = 1 if *MSDAT card is to be read, giving all numerical values *besides* blanks that are to be treated as missing data
NFMT	12	Number of Variable-Format Cards to precede each data deck
MOBS(1)	13–15	Number of subjects in deck one
MOBS(2)	16–18	Number of subject in deck two (if any)

Note: Parameters must be restricted so that $2 \leq \text{NSMPLS} * \text{NTIMES} \leq 10$.

Variable-Format Card(s)

Parameter	*Columns*	*Contents*
	1– 6	*FORMT
FMT(1)	7–72	Format for one set in the following deck by using F or E notation. (The format may be continued on more cards, in which case *FORMT must be punched in Cols. 1–6 of each continuation card)

A set consists of a number of cards (usually one) on which are punched the data for NSMPLS samples on one subject.

Sample-Name Card

One *SNAME card precedes each deck and gives identifying names to the NSMPLS in that deck.

continued

Parameter	*Columns*	*Contents*
	1– 6	*SNAME
	7– 8	Blank
SID(1)	9–14	Identification for first sample of the deck
SID(2)	15–20	Identification for second sample of the deck
⋮	⋮ etc.	⋮
SID(NSMPLS)		Identification for last sample of the deck

Missing-Data Card

Parameter	*Columns*	*Contents*
	1– 6	*MSDAT
NMISS	7– 8	Number of numerical values (besides blank) that are to be treated as missing data
UNSUIT(1)	9–13	First value to be excluded
UNSUIT(2)	14–18	Second value to be excluded
⋮	⋮ etc.	⋮
UNSUIT(NMISS)		Last value to be excluded

Setup Card(s)

Parameter	*Columns*	*Contents*
	1– 6	*SETUP
NCTGYS	7– 8	Number of categories to be defined and/or deleted for the test that this card specifies (This card is immediately followed by *CTGRY cards equal in number to NCTGYS, 1 $\leq$ NCTGYS $\leq$ 10)
IDENT	9–14	Alphanumeric identification for this test

continued

Parameter	*Columns*	*Contents*
IROUND	15–16	Power of 10 to be used in rounding off numerical values in determining classifications into categories (usually 4)
IXFEQ	17	Zero (punched)
ISMPLS	18–19	Number of samples to be used to form the table; i.e., the table will have ISMPLS row ($2 \le \text{ISMPLS} \le 10$)
	Special Case:	If 99 is punched in Cols. 18–19, all NSMPLS*TIMES samples will be used and the rest of this card ignored
LSMPLS(1)	20–21	Sample number of first sample to be used
LSMPLS(2)	22–23	Sample number of second sample to be used
⋮	⋮ etc.	⋮
LSMPLS(ISMPLS)		Sample number of last sample to be used

Category Cards

Parameter	*Columns*	*Contents*
	1– 6	*CTGRY
J	7– 8	If $1 \le J \le 10$, category J will be defined on the rest of this card If $-10 \le J \le -1$, category J is being deleted and the rest of this card is to be ignored
CID(J)	9–14	Alphanumeric identification for this category
JTYPE(J)	15	**Category J** can be specified in one of three ways by using M parameter CTGY (J,1), CTGY (J,2),···, CTGY (J,I),···, CTGY (J,M) = 1: implies that category J is the subset of M numerical values CTGY (J,1) step where $1 \le M \le 50$ and I = 1,···,M. (A sample value belongs in this category if it is equal to one of the values CTGY (J,1) plus or minus 10**IROUND)

continued

Parameter	*Columns*	*Contents*
		= 2: implies that category J is the subset of numerical values from CTGY (J,1) step CTGY (J,2) until CTGY (J,3), where M = 3, CTGY (J,1) $\le$ CTGY (J,3), and CTGY (J,2) > 0. (A sample value belongs to this category if it is equal to some member of the above progression plus or minus 10**IROUND)
		= 3: implies that category J consists of as many as 12 intervals
		—The first interval extends from CTGY (J,1) to CTGY (J,2), where CTGY (J,1) $\le$ CTGY (J,2) and is closed on the left if CTGY (J,3) > 0 and is closed on the right if CTGY (J,4) > 0.
		—The second interval extends from CTGY (J,5) to CTGY (J,6), where CTGY (J,5) $\le$ CTGY(J,6) and is closed on the left if CTGY (J,7) > 0 and is closed on the right if CTGY (J,8) > 0.
		—Etc.
	Note:	A subject in any sample can be classified in only one category. Therefore, if overlapping categories are defined, the subject will be placed in the *lowest-numbered* category for which he qualifies.
M	16–17	$1 \le M \le 50$ if JTYPE (J) ≤ 1 M = 3 if JTYPE (J) =2 $4 \le M \le 48$ if JTYPE ≤ 3
CTGY(J,1)	18–22	First parameter defining category J
CTGY(J,2)	23–27	Second parameter defining category J
⋮	⋮	
CTGY(J,11)	68–72	Eleventh parameter defining category J

If and only if M > 11, a card having *ETC1$$ in the first seven columns must follow the *CTGY card. Columns 8–72 of this card will contain the values of CTGY(J,12) through CTGY(J,24) in 13 F fields of five columns each.

continued

If and only if M > 24, a card having *ETC2$$ in the first seven columns must follow the *ETC1$$ card. Columns 8–72 of this card will contain the values of CTGY(J,25) through CTGY(J,37) in 13 F fields of five columns each.

If and only if M > 37, a card having *ETC3$$ in the first seven columns must follow the *ETC2$$ card. Columns 8–72 of this card will contain the values of CTGY(J,38) through CTGY(J,50) in 13 F fields of five columns each.

Reset Card

Parameter	*Columns*	*Contents*
	1– 6	*RESET

Input of Frequencies (NSMPLS = 99 on *INPUT card)

Instead of calculating frequencies from raw data, the frequencies can be read in by rows (samples) with columns representing categories. NFMT Variable-Format Cards are used to specify the format for reading ICTGYS frequencies; the format is used over for each of the ISMPLS samples. When this option is used, only one *SETUP card can follow the *INPUT card, and the *SETUP card must be immediately followed by a *RESET card.

Problem Card

Parameter	*Columns*	*Contents*
	1– 6	*INPUT
NSMPLS	7– 8	99 (punched)
	9–11	Blank
NFMT	12	Number of Variable-Format Cards
	13–80	Blank

Sample-Name Card

Parameter	*Columns*	*Contents*
	1– 6	*SNAME
ISMPLS	7– 8	Number of samples (rows) to be read (2 ≤ ISMPLS ≤ 10)
SID(1)	9–14	Identification for the first sample (A6)

continued

Parameter	*Columns*	*Contents*
SID(2)	15–20	Identification for the second sample (A6)
⋮	⋮	⋮

Category-Name Card

Parameter	*Columns*	*Contents*
	1– 6	*CNAME
ICTGYS	7– 8	Number of categories (columns) to be read ($2 \leq$ ICTGYS ≤ 10)
CID(1)	9–14	Identification for the first category (A6)
CID(2)	15–20	Identification for the second category (A6)
⋮	⋮	⋮

Setup Card

Parameter	*Columns*	*Contents*
	1– 6	*SETUP
IDENT	9–14	Identification for this test (A6)
IXFEQ	17	Zero (punched)

Reset Card

Parameter	*Columns*	*Contents*
	1– 6	*RESET

Card Order

(i) CDC 6400 System cards
(ii) Problem Card (*INPUT)
(iii) Sample-Name Card (*SNAME)
(iv) Category-Name Card (*CNAME)
(v) NFMT Variable-Format Cards (*FORMT)
(vi) Frequencies
(vii) Setup Card (*SETUP)
(viii) Reset Card (*RESET)

Repeat if necessary

continued

Input of Expected Frequencies

Instead of calculating expected frequencies, expected frequencies may be read by rows (samples) with columns representing the categories. The variable format must be specified on *one* *FORMT card to read ICTGYS expected frequencies; the format is used over for each of the ISMPLS samples. Each sample starts on a new card. All cards are punched as under (1) or (2) except that IXFEQ = 1 on the *SETUP card.

Card Order

(i) CDC 6400 System cards
(ii) Problem Card (*INPUT)
(iii) For I = 1 to NTIMES, repeat the following sequences. NFMT Variable-Format Card(s) (*FORMT), Sample-Name Card (*SNAME), MOBS(1) sets of Data Cards [each set containing the raw data for samples (I-1)*NSMPLS + 1 through I * NSMPLS]
(iv) Missing-Data Card (if any)
(v) Setup Card (*SETUP)
(vi) NCTGYS Category Card (*CTGRY)
(vii) Variable-Format Cards for expected frequencies (*FORMT)
(viii) Expected frequencies

Description of Output

The first line consists of a heading and, if MREAD = 0, no frequencies or expected frequencies are read in; if MREAD = 1, then the above are read in and not calculated. The next set consists of the sample identifications and the number of observations in each, followed by the number of missing-data values removed in each sample.

The next section consists of a heading for the trail number, the number of categories, the number of resets (+ 1) that have occurred, the IROUND value, the IXFEQ (= 0 or 1), and the number of the samples that are going to be used to form the table. Next follows the category numbers, the category identifications and the number of categories. The final specification of the categories follows this with the specification of the various variables being used. After this are the unclassifiable observations for each sample and the values of the observation.

The next section consists of the calculated CHISQR and the degree of freedom, the C coefficient, and the total number of observations in the samples for the given trial. It is followed by the contingency tables of the calculated frequencies, the expected frequen-

continued

cies, and the percentages of samples in categories and percentages of categories in samples.

Limitations

$2 \le \mathrm{ISMPLS} \le 10$
Each sample consists of no more than 1000 subjects

$1 \le M \le 50$

$2 \le \mathrm{NSMPLS*NTIMES} \le 10$

$1 \le \mathrm{NCTGYS} \le 10$

Job Deck Structure

```
Job Card
LIBRARY(CHISQR)
LGO.
7-8-9  (EOR card)
       Program Control Cards and data decks (see
        User Instructions)
6-7-8-9  (EOI card)
```

SAMPLE INPUT

```
VLORR,CH            ,CM42000.   CHISQR
LIBRARY(CHISQR)
LGO.
*INPUT050111100
*FORMT(5F1.0)
*SNAME  ONE---TWO---THREE-FOUR--FIVE--
 8965
24346
65464
98746
64313
98413
35189
37861
19878
12300
34221
44632
56542
51321
 7621
87945
97543
94343
  :
  :
24853
38963
34578
95638
   35
34528
37845
21549
24973
64643
66666
34573
 6627
55 33
57621
  :
  :
24665
34256
32548
32246
32447
35795
9842
*MSDAT01     9
*SETUP03TRIAL1-40 3 1 2 3
*CTGRY01GOOD--103     0     1     2
*CTGRY02MEDIUM304     2     4
*CTGRY03BAD---203     5     1     8
*SETUP01TRAIL2-40 3 1 2 3
*CTGRY-3
*SETUP01TRIAL3-40 3 1 2 3
*CTGRY 3WORSE-203     4     1     7
*SETUP00TRIAL4-40 2 4 5
*SETUP01TRIAL5-40 3 1 2 3
*CTGRY-1
*SETUP00TRIAL4-40 2 4 5
*RESET
```

SAMPLE OUTPUT

```
CHI-SQUARE TESTS (INDEPENDENT SAMPLES)          MREAD=0

    SAMPLE ID.    NUMBER OBS.

        ONE---            100
        TWO---            100
        THREE-            100
        FOUR--            100
        FIVE--            100


MISSING DATA VALUES REMOVED.....BLANK,   9.000,

        ONE---             64
        TWO---             98
        THREE-             89
        FOUR--             92
        FIVE--             91


CHI-SQ TEST ID. TRIAL1

ICTGYS=  3   IRESET= 1   ROUND=10.0000000E-05   IXFEQ= 0
SMPLS= 3....  1  2  3


 CTGY NO.   CTGY ID    ICTGYS

       1    GOOD--          3
       2    MEDIUM          3
       3    BAD---          3

FINAL SPECIFICATION OF CATEGORIES.
CTGRY 1,GOOD--,1, 3,   0.000,   1.000,   2.000,
CTGRY 2,MEDIUM,3, 4,   2.000,   4.000,  -0.000,  -0.000,
CTGRY 3,BAD---,2, 4,   5.000,   6.000,   7.000,   8.000,


THE FOLLOWING (IF ANY) ARE UNCLASSIFIABLE.
  SAMPLE     NUMBER    OBSERVATION

 ONE---- 1      12  4.0000000E+00
 TWO---- 2       2  4.0000000E+00
 TWO---- 2       5  4.0000000E+00
 TWO---- 2      11  4.0000000E+00
 TWO---- 2      12  4.0000000E+00
     :           :           :
 THREE-- 3      33  4.0000000E+00
 THREE-- 3      34  4.0000000E+00
 THREE-- 3      37  4.0000000E+00
 THREE-- 3      38  4.0000000E+00
 THREE-- 3      75  4.0000000E+00
 THREE-- 3      80  4.0000000E+00

   FINISH
```

continued

```
HISQ=    23.788 FOR   4 DEGREES OF FREEDOM.
ONTINGENCY COEFFICIENT= .314
OTAL NO. OBSERVATIONS= 218.0


REQUENCIES.


        GOOD--  MEDIUM  BAD---

ONE---   17.00   22.00   24.00

WO---    19.00    5.00   55.00

HREE-    17.00   11.00   48.00


XPECTED FREQUENCIES.


        GOOD--  MEDIUM  BAD---

NE---    15.32   10.98   36.70

WO---    19.21   13.77   46.02

HREE-    18.49   13.25   44.28



      0 CELLS HAVE EXPECTED FREQUENCY LESS THAN ONE.
      0 PERCENT OF THE CELLS HAVE EXPECTED FREQUENCY LESS THAN FIVE.



ERCENTAGES OF SAMPLES (I.E. ROWS) IN CATEGORIES.


        GOOD--  MEDIUM  BAD---

NE---    26.98   34.92   38.10

WO---    24.05    6.33   69.62

HREE-    22.37   14.47   63.16


ERCENTAGES OF CATEGORIES (I.E. COLUMNS) IN SAMPLES.


        GOOD--  MEDIUM  BAD---

NE---    32.08   57.89   18.90

WO---    35.85   13.16   43.31

HREE-    32.08   28.95   37.80
           :       :       :       :
           .       .       .       .
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 2.036 seconds of central-processor time and 17.384 seconds of peripheral-processor time with a memory useage of 42,000 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—CHISQR

pages

1,2 Identification & Abstract
3–10 User Instructions
11–13 I/)
15 Cost—Contents

DESCRIPTIVE TITLE	Discriminant Analysis for Two Groups
CALLING NAME	DISCRIM NUCC169
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Biometrics Laboratory University of Miami
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

DISCRIM computes a discriminant function for contrasting two groups and tests its significance. It also scores each subject by using the discriminant-function coefficients. The analysis may be repeated on subsets of the original variables.

Rao's[1] discriminant-function coefficients are multiplied by a constant so that the sum of squares of the coefficients is equal to one; these are printed under the heading RAW DISCRIMINANT FUNCTION COEFFICIENTS.

REFERENCES

1. Rao, C.R., *Advanced Statistical Methods in Biometric Research* (John Wiley & Sons, Inc., New York, 1952), pp. 237–238, 246–248.

Anderson, T.W., *An Introduction to Multivariate Statistical Analysis* (John Wiley & Sons, Inc., New York, 1958), pp. 126–138.

USER INSTRUCTIONS

Preparation of Data

DISCRIM expects cards in the following sequence:

Title Card

Columns	*Contents*
1–72	Any alphanumeric information to be printed on all output sheets

Problem Card

Columns	*Contents*
1– 5	Number of variables, right-justified (maximum 100)
6–10	Number of subjects in first group, right-justified
11–15	Number of subjects in second group, right-justified
16	Blank
17	Number of extra Variable-Format Cards (in addition to this card)
18	Blank: program will number variables consecutively beginning with 1 =1: names of variables supplied
19	Number of reselections of original variables
20	Blank: the listing of sorted discriminant scores will be printed unless the number of subjects in the combined groups exceeds 5000 or the number of subjects in one group exceeds 4500 (the program always computes discriminant scores and prints the classification table)
37–72	Variable format for one subject (must begin and end with parentheses and include subject identification in A format, followed by his scores in F format)

Variable-Format Card(s) (optional)

Columns	*Contents*
1–72	Continuation of variable format, if needed. (Up to 9 extra cards may be used, as specified in Col. 17 of the Problem Card)

continued

Group-Name Card

Columns	*Contents*
1–12	Name of first group
13–24	Name of second group

Variable-Name Card(s) (optional)

Columns	*Contents*
1– 6	Name of first variable (any alphanumeric characters)
7–12	Name of 2nd variable
⋮	⋮
67–72	Name of 12th variable. Continue on as many additional cards as necessary. (The total number of names must equal the number of variables)

Data Cards

The subject identification is first, followed by his scores on the first variable, on the second variable, etc. The columns must conform to the variable-format statement.

Reselection Cards (optional)

Columns	*Contents*
10–11	Number of variables reselected
12	Card number within reselection, beginning with blank or zero
13–15	Number of first reselected variable
16–18	Number of 2nd reselected variable
⋮	⋮
70–72	Number of 20th reselected variable. Continue on as many additional cards as necessary, each to be numbered in Col. 12 and containing up to 20 variable numbers per card

Finish Card

Columns	*Contents*
1– 6	FINISH

continued

Limitations

1. No more than 100 variables
2. No more than 99,999 subjects in each group; the two groups may be unequal in size
3. The number of subjects must exceed the number of variables
4. No missing data. If score is missing (blank or minus zero on the Data Card), it will be detected and that subject will be omitted from the analysis

Job Deck Structure

```
Job Card
REQUEST(TAPE4) HAND XXXX (if data are on tape)
LIBRARY(DISCRIM)
LGO.
7-8-9 (EOR card)
       Title Card
       Problem Card               ----------------
       Variable-Format Card(s) (optional)        |    May be
       Group-Name Card                           |    repeated for
       Variable-Name Card(s) (optional)          |    additional
       Data Cards                                |    problems
       Reselection Cards (optional)              |
                                  ----------------
FINISH Card
6-7-8-9 (EOI card)
```

SAMPLE INPUT

```
VLCRR,CH            ,CM76100,    DISCRIM
LIBRARY(DISCRIM)
LGO.
PATIENTS# HISTORY ITEMS AS PREDICTORS OF DRUG RESPONSE AFTER FIVE WEEKS
    5   13   20 11                   (6X, A3, 23X, F1.0 / 14X, F1.0,
F2.0, 9X, F1.0, 4X, F1.0)
 RESPONDERS NON-RESPOND.
ONSET HOSP  WEEKS EDUCA OCCUPA
04     101 012618        13231 2  5         11 5555545555455555624l121
04     101 02260 0      0038222171l2117189    11 6 2 9 0 0 00
04     103 012921   1 1  2112 8364           1 5555525555555555225l332
04     103 02290 0      00373222831212        466 1 2 4 0 0 011522
04     107 014111   1 1  2231 7  5111  11111135555555555555556243111
04     107 02380 0      0038322261122     39  16 4 2 3 0 1 02    75
04     117 013221   1 1  2231 2 12           1 2552555555555555558145111
04     117 0225219111  142253222761221  5532  46 1 0 1 0 0 0120267E
04     119 012318        1311  4 531    11111 55555455444455556234
04     119 02150 0   1  013712227112114664    66 2 1 2 0 0 00
04     129 014511   1 1  21344570511  11  111513453555515555552151221
04     129 0244212 1    2328122258411290   1016 4 3 8 0 1 0217  77
04     130 013717  1     1124 4324111   1 11 5555515 551155556244121
04     130 0231540111  1052412224l121 65    411 2 1 2 0 0 01212045
04     131 012421   1 1  2114 5 321111 1 1111535554555445554541412 22
04     131 02171 2 1   84436122175121 15558    15 1 7 5 0 0 11182656

             :        :         :         :         :

04     123 014827      11 223316  5111 111111444444444444444446244121
04     123 02330 0      00383221784222        66          1   78
04     124 012717 11 1   1121 6  61 1 1     1 5555525545355555625511l
04     124 0216260 1   22224112278111 15052    11 1 0 1 0 0 012419
04     125 013626  1     213120  6 1  1    1115454524545324455211111l
04     125 02320 0 1 1   025222283121262     126 0 0 1 0 0 01172236
04     133 013811    1   2113106051 1 111111155555553151511556223321
04     133 02370 0      003422224l1221  63    4  0 2 1 0 0 0230  48
04     135 0136181       3112 1  61 1 1 1 11 155554555444455456234121
04     135 02360 0       0341222711222    353566 1 0 2 0 0 00
04     136 015824     1  112  6 321   1   11 5554545555235555622
04     136 02552  11     236333276222           66 5 2 1      123
04     138 012318  1 1   113410 931 1 111 11 5555515555555555812331l
04     138 02230 0      002522216111114461    15 3 2 3 0 0 00
04     139 013211   1 1  2232 9284  1 1 1 1114555555555555555511211 11
04     139 02320 0 1    001522217111115564    11 3 6 4 0 0 01201975
04     141 012318  1     1112 4785   1 1 11115551555555115555812111
04     141 02210 0 1 1  022522224842115454    41 0 0 1 0 0 00
04     142 013727     1 1 215429  6111     11 153555153552254558251 22
04     142 02311 3 1     125222243321262    1811 4 2 5 0 0 02202255
04     143 014518 11     111212 53      1 111 555554555153455453141111
04     143 0243112 11  31324222238411117383    15 1 1 3 0 0 00
04     147 0149261       3151 8  5      1 111 5554543344445555623333
04     147 02490 0      003632228342          66 0 1 1 0 1 0126  55
04     149 014227  1  1  1234103041 1 11 111 55555255555555555812112l
04     149 02313  11   13414222283121253    3511 0 0 1 0 0 011730 4
FINISH
```

SAMPLE OUTPUT

```
VOGELBACK COMPUTING CENTER
NORTHWESTERN UNIVERSITY

D I S C R I M  - -  DISCRIMINANT ANALYSIS FOR TWO GROUPS




              PATIENTS# HISTORY ITEMS AS PREDICTORS OF DRUG RESPONSE AFTER FIVE WEEKS




FORMAT OF DATA CARDS                 (6X, A3, 23X, F1.0 / 14X, F1.0,
F2.0, 9X, F1.0, 4X, F1.0)
           SUBJECT 136   OMITTED FROM ANALYSIS BECAUSE OF MISSING DATA
           SUBJECT 149   OMITTED FROM ANALYSIS BECAUSE OF MISSING DATA



                                                CORRELATIONS


VARIABLE     ONSET   HOSP    WEEKS   EDUCA


 HOSP        -.352


 WEEKS       -.304    .801


 EDUCA        .447   -.417   -.234


 OCCUPA       .379   -.398   -.083    .657



MEANS, STANDARD DEVIATIONS
                              RESPONDERS                              NON-RESPOND.
                              13 SUBJECTS                              18 SUBJECTS
                                         STANDARD                                 STANDARD
   VARIABLE             MEAN             DEVIATION           MEAN                 DEVIATION


    ONSET               3.231               1.536            4.278                   1.638
    HOSP                1.308               1.797             .778                   1.166
    WEEKS               8.923              12.790           13.167                  24.945
    EDUCA               6.000               1.958            5.056                   1.349
    OCCUPA              5.385               2.293            5.944                   1.765
```

continued

```
ANALYSIS OF ALL INPUT VARIABLES


             MULTIPLE CORRELATION        DIFFERENCE OF MEANS                    RAW DISCRIMINANT          CONTRIBUTION
  VARIABLE  WITH ALL OTHER VARIABLES    GROUP 1 MINUS GROUP 2        T         FUNCTION COEFFICIENT        TO D-SQUARE

   ONSET             .511                    -1.0470               1.80            -.389190                   .7437
   HOSP              .868                      .5299               1.00             .708243                   .6850
   WEEKS             .846                    -4.2436                .56            -.044513                   .3448
   EDUCA             .703                      .9444               1.59             .578607                   .9974
   OCCUPA            .742                     -.5598                .77            -.100771                   .1030
                                                            CONSTANT TERM =   -1.413335   D-SQUARE =    2.8738

F(  5,   25) =   3.7401                          P LESS THAN    .0115


RESELECTION NO. 0 - DISCRIMINANT SCORES, RANKED AND MERGED
                   CUTOFF =       .5479 * LOG((P2*C2)/(P1*C1))    P1 = A PRIORI PROBABILITY THAT A SUBJECT COMES FROM GROUP 1
                                                                  P2 = A PRIORI PROBABILITY THAT A SUBJECT COMES FROM GROUP 2
                                                                  C1 = COST OF MISCLASSIFYING A SUBJECT WHO IS ACTUALLY IN GROUP 1
                                                                  C2 = COST OF MISCLASSIFYING A SUBJECT WHO IS ACTUALLY IN GROUP 2
          SUBJECT           RESPONDERS     NON-RESPOND.


           145                2.1719
           129                1.6480
           131                1.1937
           137                1.0388
           119                 .7639
           120                                 .7052
           130                 .7020
           118                                 .6753
           107                 .6649
           117                 .5667
           101                 .5642
           144                 .5642
           123                                 .5642
           140                 .3627
           112                                 .3481
           103                 .2740
           109                                 .0599
           134                -.2804
           138                                -.2925
           143                                -.3947
           142                                -.6838
           147                                -.6938
           139                                -.7825
           141                                -.8693
           108                               -1.0070
           102                               -1.0178
           133                               -1.4479
           125                               -1.6616
           122                               -2.1394
           135                               -2.1394
           124                               -3.3937
```

```
CLASSIFICATION TABLE (ASSUMING EQUAL A PRIORI PROBABILITIES AND EQUAL COSTS)
          ACTUAL                   CLASSIFIED AS
                              RESPONDERS     NON-RESPOND.

         RESPONDERS               12              1


        NON-RESPOND.               5             13


MEAN AND STANDARD DEVIATIONS OF DISCRIMINANT SCORES
                                                STANDARD         NUMBER OF
          GROUP                   MEAN          DEVIATION         SUBJECTS

        RESPONDERS                .787             .622              13

       NON-RESPOND.              -.787            1.095              18

         COMBINED                -.127             .929              31
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 0.744 seconds for central-processor time and 18.791 seconds for peripheral-processor time with a memory useage of 76,100 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—DISCRIM

pages

1 Identification & Abstract
3–5 User Instructions
7–10 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Eigensystems of Nonsymmetric, Real Square Matrices
CALLING NAME	EIGSYS NUCC126
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	James Van Ness Department of Electrical Engineering, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201. Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

EIGSYS produces all eigenvalues and eigenvectors (both real and complex) of either symmetric or nonsymmetric square matrices having real elements. EIGSYS calls various subroutines to calculate the eigenvalues, the determinant and the eigenvectors. The trace and determinant of input matrix A is compared with the sum and product, respectively, of the E values. The righthand eigenvectors X(I) and the lefthand eigenvectors V(J) of A are printed along with their respective residual vectors (A*X(I) - LAMBDA(I)*X(I)) and V(J)*A-V(J)*LAMBDA(J)). The squares of the residual vectors are printed for convenience in checking the accuracy of the eigensystem. After finding each E vector, EIGSYS then uses the Rayleigh quotient[1] scheme to correct the original E value, which in turn produces a corrected E vector along with new residuals. A second correction is applied that produces a further refinement of the eigenvalue only. The sum and product of the corrected E values are printed at the end of the output for each matrix. EIGSYS repeats this computation for each matrix in the data-input stream.

REFERENCES

1. Martin, R.S., and Wilkinson, J.H., "Solution of Symmetric and Asymmetric Band Equations and the Calculation of Eigenvectors of Band Matrices," Numer. Math. *9*, 279–301 (1959).

USER INSTRUCTIONS

Description of Input

Control Cards

Parameter	*Columns*	*Contents*
N	1– 2	Number of rows (and columns) in input matrix
	3–15	Blank
IFMT	16–79	Variable format to be used in reading input matrix
	80	Blank

Data Cards

An input matrix is read in rowwise according to IFMT (variable format; N rows are read, each containing N elements). Each new row begins on a new card.

Note: The sequence of cards above (including a new Control Card) may be repeated for as many matrices as needed. However, the maximum size that EIGSYS is able to handle for any particular array is 46X46.

Description of Output

1. Input matrix A
2. Eigenvalues as found with the iteration number on which the algorithm converged to that value
3. Eigenvalues repeated with ordinal number
4. Trace and determinant of A compared with the sum and product of the eigenvalues
5. Righthand eigenvector X and lefthand eigenvector V along with their respective residuals (A*X-LAMBDA*X) and (V*A-VLAMBDA) printed columnwise with the value of lambda used
6. Eigenvalue condition indicators SW1, COUNT, and ERR (see description of parameters SW1, ITER and DIF in subroutine EIGVEC writeup[1])
7. Squares of the residual vectors can be used as an estimate of the accuracy of the eigenvalue–eigenvectors
8. Corrected eigenvalue (from the Rayleigh-quotient device)
9. Steps 5,6,7 are repeated, using the corrected eigenvalue
10. Record-order corrected eigenvalue is displayed

continued

11. Steps 5–10 repeated for each eigenvalue
12. Step 4 repeated at the end of the output, using the corrected eigenvalues
13. Steps 1–12 are repeated for each input matrix

Error Indications

Appropriate warning messages are printed by subroutine EIGVEC when apparent multiple eigenvalues are detected and/or when EIGVEC fails to converge in 15 iterations.

Job Deck Structure

```
Job Cards
LIBRARY(EIGSYS, EIGVEC, ASQR, HESSEN, QREIG, DE1SP)

LGO.

7–8–9 (EOR Card)

    Control Card for 1st input matrix   ─┐
    Data Cards   for 1st input matrix    │
    Control Card for 2nd input matrix    │  Repeat for any
    Data Cards   for 2nd input matrix    │
                      .                  │  additional matrices
                      .                  │
                      .                  │
                                        ─┘

6–7–8–9 (EOI Card)
```

REFERENCES

1. Mazukelli, D., Waye, E., and Van Ness, J.E., "Eigenvectors of the Real Square Nonsymmetric Matrix," Northwestern Univ. Computing Ctr. Library Program EIGVEC NUCC127 (subroutine) (1967).

SAMPLE INPUT

```
VLORR.CH             ,0450700.     FIGSYS
LGO.
LIBRARY(FIGSYS,FIGVEC,ASQR,HESSEN,ORFIG,DFISP)
 8100            (8F2.0)                                                           MASTER 8
 2 0 4 1                                                                           MX 8 0 1
 0 4 2 0                                                                           MX 8 0 2
 4 2 3 2                                                                           MX 8 0 3
 1 0 2 3                                                                           MX 8 0 4
 0 0 0 0 2 0 4 1                                                                   MX 8 0 5
 0 0 0 0 0 4 2 0                                                                   MX 8 0 6
 0 0 0 0 4 2 3 2                                                                   MX 8 0 7
 0 0 0 0 1 0 2 3                                                                   MX 8 0 8
 2                    (2F2.0)                                                      2X2NONSY
 1 2                                                                               2X2NONS1
 1 3                                                                               2X2NONS2
 6 10     1. E -5(6F2.0)                                                           MASTER 6
 1 2 3 4 5 6                                                                       MX 6 0 1
 2 3 4 5 6 7                                                                       MX 6 0 2
 3 4 5 6 7 8                                                                       MX 6 0 3
 4 5 6 7 8 9                                                                       MX 6 0 4
 5 6 7 8 910                                                                       MX 6 0 5
 6 7 8 91011                                                                       MX 6 0 6
 8                       (8E8.0)                                                   8X8VK 00
 1.0E+00 1.0E+01 1.0E+02 1.0E+03 1.0E+04 1.0E+05 1.0E+06 1.0E+07                   8X8VK 01
 1.0E+01 1.0E+02 1.0E+03 1.0E+04 1.0E+05 1.0E+06 1.0E+07 1.0E+08                   8X8VK 02
 1.0E+02 1.0E+03 1.0E+04 1.0E+05 1.0E+06 1.0E+07 1.0E+08 1.0E+09                   8X8VK 03
 1.0E+03 1.0E+04 1.0E+05 1.0E+06 1.0E+07 1.0E+08 1.0E+09 1.0E+10                   8X8VK 04
 1.0E+04 1.0E+05 1.0E+06 1.0E+07 1.0E+08 1.0E+09 1.0E+10 1.0E+11                   8X8VK 05
 1.0E+05 1.0E+06 1.0E+07 1.0E+08 1.0E+09 1.0E+10 1.0E+11 1.0E+12                   8X8VK 06
 1.0E+06 1.0E+07 1.0E+08 1.0E+09 1.0E+10 1.0E+11 1.0E+12 1.0E+13                   8X8VK 07
 1.0E+07 1.0E+08 1.0E+09 1.0E+10 1.0E+11 1.0E+12 1.0E+13 1.0E+14                   8X8VK 08
                                                    .       .                          .
                                                    .       .                          .
                                                    .       .                          .

                                                    .       .                          .
```

SAMPLE OUTPUT

```
... INPUT MATRIX FOLLOWS ...

ROW NO.  1
           2.000E+00   0.          4.000E+00   1.000E+00  -0.         -0.         -0.         -0.
ROW NO.  2
           0.          4.000E+00   2.000E+00   0.         -0.         -0.         -0.         -0.
                  .           .           .
                  .           .           .
                  .           .           .
ROW NO.  7
           0.          0.          0.          0.          4.000E+00   2.000E+00   3.000E+00   2.000E+00
ROW NO.  8
           0.          0.          0.          0.          1.000E+00   0.          2.000E+00   3.000E+00


    REAL PART       IMAGINARY PART                      TAKEN AS ZERO      ITERATION NO.

  1.95639324E+00     0.                                                         8
 -1.94060378E+00     0.
  8.06525883E+00     0.                                                         1
  3.91895171E+00     0.
  1.95639324E+00     0.                                                         8
 -1.94060378E+00     0.
  8.06525883E+00     0.                                                         1
  3.91895171E+00     0.



EIGENVALUES FOUND BY QREIG

  NO.( 1)  3.918951707E+00 0.                NO.( 2)  8.065258831E+00 0.                NO.( 3) -1.940603775E+00 0.
  NO.( 4)  1.956393239E+00 0.                NO.( 5)  3.918951707E+00 0.                NO.( 6)  8.065258831E+00 0.
  NO.( 7) -1.940603775E+00 0.                NO.( 8)  1.956393238E+00 0.                NO.(


 TRACE OF INPUT MATRIX =  2.400000000E+01          DETERMINANT OF INPUT MATRIX =  1.440000000E+04 *    0
    SUM OF EIGENVALUES =  2.400000000E+01              PRODUCT OF EIGENVALUES =  1.440000000E+04
```

continued

```
R. H. E-VECTOR OF A   L. H. E-VECTOR OF A    (A*X - LAMBDA*X)     (V*A - V*LAMBDA)     FOR LAMBDA( 1) =  3.918951707E+0

 -3.012837464E-01      -3.012837464E-01      -6.944802297E-13     -6.845662964E-13
  1.000000000E+00       1.000000000E+00       2.281286271E-12      2.286171252E-12
 -4.052414642E-02      -4.052414642E-02      -8.345095694E-14     -7.148463318E-14
 -4.160523739E-01      -4.160523739E-01      -9.495936333E-13     -9.461970675E-13
 -3.012837464E-01      -3.012837464E-01      -6.944802297E-13     -6.845662964E-13
  1.000000000E+00       1.000000000E+00       2.281286271E-12      2.286171252E-12
 -4.052414642E-02      -4.052414642E-02      -8.345095694E-14     -7.148463318E-14
 -4.160523739E-01      -4.160523739E-01      -9.495936333E-13     -9.461970675E-13


SW1 =  6.938449815E-12   COUNT =  2   ERR =  4.820366328E-12
R.H. RESIDUAL VECTOR SQUARED =  1.319052394E-23   L.H. RESIDUAL VECTOR SQUARED =  1.319121790E-23
                          .             .             .
                          .             .             .
                          .             .             .
```

continued

```
THE CORRECTED REAL EIGENVALUE ( 8) =   1.956393238E+00


  R. H. E-VECTOR OF A   L. H. E-VECTOR OF A    (A*X - LAMBDA*X)      (V*A - V*LAMBDA)     FOR LAMBDA( 8) =  1.956393238E+00

   -5.557234117E-01      -5.557234117E-01      2.061173146E-15      2.216095487E-15
    2.387364143E-01       2.387364143E-01      1.966828348E-15      1.966828348E-15
   -2.439416753E-01      -2.439416753E-01      1.851281995E-14      3.272367466E-14
    1.000000000E+00       1.000000000E+00      5.329070518E-15      8.881784197E-15
   -5.557234117E-01      -5.557234117E-01      2.061173146E-15      2.216095487E-15
    2.387364143E-01       2.387364143E-01      1.966828348E-15      1.966828348E-15
   -2.439416753E-01      -2.439416753E-01      1.851281995E-14      3.272367466E-14
    1.000000000E+00       1.000000000E+00      5.329070518E-15      8.881784197E-15

SW1 =  7.105427358E-15   COUNT =  2   ERR =  5.329070518E-15
R.H. RESIDUAL VECTOR SQUARED =  7.584806869E-28   L.H. RESIDUAL VECTOR SQUARED =  2.317008934E-27



THE CORRECTED REAL EIGENVALUE ( 8) =   1.956393234E+00



MATRIX PROPERTIES REPRINTED HERE USING CORRECTED EIGENVALUES


TRACE OF INPUT MATRIX =  2.400000000E+01            DETERMINANT OF INPUT MATRIX =  1.440000000E+04 *   0
   SUM OF EIGENVALUES =  2.400000000E+01                  PRODUCT OF EIGENVALUES =  1.440000000E+04

                         .            .            .
                         .            .            .
                         .            .            .
```

COST ESTIMATE

For the job in the Sample Input, the total time was 0 seconds for central-processor time and 1.061 seconds for peripheral-processor time with a memory useage of 50,700 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—EIGSYS

pages

1	Identification & Abstract
3,4	User Instructions
5–8	I/O
9	Cost—Contents

DESCRIPTIVE TITLE	Program Deck Identification Field Sequencing Program
CALLING NAME	IDSEQN NUCC128
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Deck and listing presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

The program reproduces FORTRAN, COMPASS, and ASCENT source decks with the ID field (Cols. 73-80) containing

(1) either a 2-, 3-, or 4-alphanumeric-character identification code;
(2) either a 1- or 2-digit subprogram number (this may be omitted if desired);
(3) either a 3- or 4-digit card-sequence number within each program.

Each time an END card (END may be in any Cols. 7-72) is encountered, the subprogram number is incremented by one. Multiple decks (with a separator card and a new control card between each deck) can be run at one time. Printed output consists of a listing of the sequenced deck (each subprogram beginning on a new page), with the original ID field printed optionally to the right of each card listing.

USER INSTRUCTIONS

Description of Input Data

The input data to IDSEQN consist of a control card, followed by the user's program deck beginning with the program card and ending with an END card. If more than one program deck is to be processed, each subsequent deck must have a separator card in front of its control card. See below for description of separator and control cards.

1. Description of the Output Options

A. Option 1 (OUTPUT)
- (i) A 2-character alphanumeric identifier (ID) punched in Cols. 73-74 of the reproduced deck
- (ii) A 2-digit subprogram number (modulo 100) punched in Cols. 75-76. This number begins with 0 and is incremented after each END card is encountered
- (iii) A 4-digit card number (modulo 10000) punched in Cols. 77-80. This number begins with 0 and is incremented by 10 for each card of a program or subprogram. It is reset after every END card

Control Card (first INPUT card)
ID in Cols. 1-2
Blanks in Cols. 3-5
ICODE in Col. 6 (see below)

B. Option 2 (OUTPUT)
- (i) ID punched in Cols. 73-75
- (ii) A single-digit subprogram deck number (modulo 10) punched in Col. 76
- (iii) Same as in Part A-(iii) above

Control Card (first INPUT card)
ID in Cols. 1-3
Blanks in Cols. 4-5
ICODE in Col. 6

C. Option 3 (OUTPUT)
- (i) ID punched in Cols. 73-76
- (ii) Single subprogram deck number (modulo 10) punched in Col. 77
- (iii) A 3-digit card number (modulo 1000, by 10's) punched in Cols. 78-80

continued

Control card (first INPUT card)
ID in Cols. 1-4
Blank or zero in Col. 5
ICODE in Col. 6

D. Option 4 (OUTPUT)
- (i) ID punched in Cols. 73-76
- (ii) Subprogram number *omitted*
- (iii) A 4-digit card number (modulo 10000, by 10's) punched in Cols. 78-80

Control Card (first INPUT card)
ID in Cols. 1-4
A nonblank, nonzero digit in Col. 5
ICODE in Col. 6

2. ICODE

A nonblank, nonzero ICODE causes *printing* of the original ID field of the input deck to the right of the new ID field on the output listing. The punched output is not affected.

3. Separator Card

The separator card is used only between decks and is always followed by a new control card. It is punched)))(((in Cols. 1-6. (3 right parens. followed by 3 left parens.)

Job Deck Structure

```
Job Card
LIBRARY(IDSEQN)
LGO. to increase line count: LGO(LC-N)
7-8-9 EOR
ID control card for deck 1
 PROG ----------------------|
 .                          |
 .                          |
 .                          |
 END                        |  Program Deck #1
 SUBROUTINE                 |  (continued on the following page)
 .                          |
 .                          |
 .                          |
 END                        |
                            |
```

continued

```
FUNCTION
.
.
.
END
  IDENT
  .
  .
  END                       Program Deck #1
SUBROUTINE                  (continued from the previous page)
.
.
.
END
.
.
.
END
)))((( Separator card
ID control card for deck 2
PROG
.
.                           Program Deck #2
.
END
PROG
.
.                           Program Deck #3
.
END
6-7-8-9 EOI
```

Description of Output

The punched output was described above. The printed output consists of a listing of the punched output with the original ID field shown at the user's option. Each program or subprogram begins on a new page.

The message JOB COMPLETED appears on a page by itself at the end of the listing.

Error Indications

None

continued

Limitations

CM required 43000 . There is no limit to the number of data cards that can be processed.

Remember that each input card requires one line of printed output and one card of punched output, so adjust your job-card parameters accordingly.

Caution: Remove all control and EOR or EOI cards from your program decks. *Do not submit your own input data unless* you want them reproduced and punched in Cols. 73-80 with sequence numbers.

SAMPLE INPUT

```
VLOBB,          ,CM43000,    IDSEQN
LIBRARY(IDSEQN)
LGO.
    0
   THE DECKS THAT FOLLOW ARE USED MERELY TO INDICATE WHAT IDSEQN DOES
   AND ARE NOT TO BE CONSTRUED AS ACTUAL PROGRAMS.

   A COPY OF
   THE CONTROL CARD FOR THE FIRST JOB FOLLOWS . .

1W   1

   THE ALPHAMERIC FIELD IN COLS. 1-2 WILL BE REPRODUCED ON ALL
   PRINTED AND PUNCHED OUTPUT IN COLS. 73-74.

   THE NON-ZERO DIGIT IN COLUMN 6 INDICATES THAT THE ORIGINAL
   IDENTIFICATION FIELD IS TO BE PRINTED UNDER THE NEW FIELD.


   THE PROGRAM RECOGNIZES ANY LEGAL END CARD AS A SUBROUTINE
   TERMINATOR.
)))(((                                                                  X1 3   0
1W   1
      PROGRAM TEST(OUTPUT,INPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE20)        2TS 4  0
C
C
C
   DEMONSTRATION OF OPTION 1
C
C
C
      END
           FUNCTION TERM(A,B)                                           2TS 1  0
           PRINT 91,A,B                                                 2TS 1  1
   91         FORMAT(2X,120(1H*)/5X,26HTERM CALLED WITH ARGUMENTS (OCTAL)2TS 1  2
    1         10X,2O20/5X,20HNO ACTION TAKEN      /2X,120(1H*))         2TS 1  3
      DO 1 I=1,100                                                      2TS 2  4
       J=2*I-1                                                          2TS 2  5
      CALL STRDIR(STRDIR(STRDIR(0,X(I)),W(J)),W(J+1))                   2TS 2  6
      CALL SETDIR(0,MADOV(W(J)),MADOV(W(J)),X(I))                       2TS 2  7
      CALL SETDIR(2,MADOV(W(J)),MADOV(W(J)),W(J))                       2TS 2  8
    1 CALL SETDIR(-1,-1,4095,W(J+1))                                    2TS 2  9
      DO 2 I=1,N                                                        2TS 2 10
    2  M(I)=0                                                           2TS 2 11
      K=N-2                                                             2TS 2 12
      DO 3 I=1,K,2                                                      2TS 2 13
    3   CALL SETDIR(-1,-1,MADOV(M(I+2)),M(I))                           2TS 2 14
      RETURN                                                            2TS 2 16
000000000111111111122222222223333333333444444444455555555556666666666777777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
                                                                              END
                                                                    END
      FUNCTION NUCELL(X)                                                2TS 3  0
      COMMON AVSL                                                       2TS 3  1
      M=LNKR(AVSL)                                                      2TS 3  2
          IF(M) 1,2,1                                                   2TS 3  3
    2  PRINT 901                                                        2TS 3  4
      STOP                                                              2TS 3  5
    1 IF (ID(CONT(M))-1)3,4,3                                           2TS 3  6
    4     CALL TRALST(CONT(M+1))                                        2TS 3  7
    3     CALL SETDIR(-1,-1,LNKR(CONT(M)),AVSL)                         2TS 3  8
          CALL STRIND(0,M)                                              2TS 3  9
      CALL STRIND(0,M+1)                                                2TS 3 10
         NUCELL=M                                                       2TS 3 11
      RETURN                                                            2TS 3 12
  901 FORMAT(1H1,6X,55HLIST OF AVAILABLE SPACE EXHAUSTED - PROGRAM TERM 2TS 3 13
     1INATED    )                                                       2TS 3 14
000000000111111111122222222223333333333444444444455555555556666666666777777777779
12345678901234567890123456789012345678901234567890123456789012345678901234567890
     R  END
C    5          E   ND
                  EEND
    E  ND
  END
000000000111111111122222222223333333333444444444455555555556666666666777777777779
12345678901234567890123456789012345678901234567890123456789012345678901234567890
END
$       END
                                                                    END
            E ND
)))(((
```

continued

```
   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...

TS9  0
)))(((
TS9  0
C
C
C
   DEMONSTRATION OF OPTION 2
C
C
C
      END
          FUNCTION VISIT(A,B)                                           TST 0  0
      PRINT 1                                                           TST 1  1
 1    FORMAT(30H REFERENCE TO VISIT WAS MADE                 ).         TST 2  2
      CALL EXIT                                                         TST 3  3
          RETURN                                                        TST 4  4
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
      E
C     END
     0    E      N         D
          FUNCTION TERM(A,B)                                            TST 6  6
          PRINT 91,A,B                                                  TST 7  7
   91        FORMAT(2X,120(1H*)/5X,26HTERM CALLED WITH ARGUMENTS (OCTAL)TST 8  8
     1       10X,2020/5X,20HNO ACTION TAKEN     /2X,120(1H*))           TST 9  9
           RETURN                                                       TST10 10
      DO 1 I=1,100                                                      TST16 16
       J=2*I-1                                                          TST17 17
      CALL STRDIR(STRDIR(STRDIR(0,X(I)),W(J)),W(J+1))                   TST18 18
      CALL SETDIR(0,MADOV(W(J)),MADOV(W(J)),X(I))                       TST19 19
      CALL SETDIR(2,MADOV(W(J)),MADOV(W(J)),W(J))                       TST20 20
    1 CALL SETDIR(-1,-1,4095,W(J+1))                                    TST21 21
      DO 2 I=1,N                                                        TST22 22
    2  M(I)=0                                                           TST23 23
      K=N-2                                                             TST24 24
      DO 3 I=1,K,2                                                      TST25 25
    3   CALL SETDIR(-1,-1,MADOV(M(I+2)),M(I))                           TST26 26
      CALL SETDIR(0,MADOV(M(N-1)),MADOV(M(1)),AVSL)                     TST27 27
      RETURN                                                            TST28 28
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
C     END
$     END
*     END
   END
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
                                                                  F  END
              ENDM
                                                                          END
                                                                   END
)))(((
```

continued

```
   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...

TST4
)))(((
TST4
C
C
C
C
   DEMONSTRATION OF OPTION 3
C                                                                       2TS 4   1
C
C
C
C
      END
      FUNCTION NULSTR(LNKP,LNKH)                                        TST**110
C                                                                       TST**111
      NULSTR=LIST(9)                                                    TST**112
      IF (ID(CONT(LNKP))-2)1,2,1                                        TST**113
    2    CALL SETIND(2,NULSTR,NULSTR,NULSTR)                            TST**114
      RETURN                                                            TST**115
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
    END
                                                                    END
      SUBROUTINE RCELL(CELL)                                            1W 0    0
C                                                                       1W 0   10
      COMMON AVSL                                                       1W 0   20
       CALL SETIND(-1,-1,CELL,LNKL(AVSL))                               1W 0   30
      CALL SETDIR(-1,CELL,-1,AVSL)                                      1W 0   40
       CALL SETIND(-1,-1,0,CELL)                                        1W 0   50
      RETURN                                                            1W 0   60
00000000011111111112222222222333333333344444444445555555555666666666677777777778
12345678901234567890123456789012345678901234567890123456789012345678901234567890
1  0 END
)))(((


   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...

TST71
)))(((
TST71
C
C
C
   DEMONSTRATION OF OPTION 4
C
C
C
      END
      SUBROUTINE RCELL(CELL)                                            BB 6    0
C                                                                       BB 6   10
      COMMON AVSL                                                       BB 6   20
       CALL SETIND(-1,-1,CELL,LNKL(AVSL))                               BB 6   30
      CALL SETDIR(-1,CELL,-1,AVSL)                                      BB 6   40
       CALL SETIND(-1,-1,0,CELL)                                        BB 6   50
      RETURN                                                            BB 6   60
000000000111111111122222222223333333333444444444455555555556666666666777BB 6   70
123456789012345678901234567890123456789012345678901234567890123456789012BB 6   80
1   0 END                                                               BB 6   90
          FUNCTION TERM(A,B)                                            BB 7    0
          PRINT 91,A,B                                                  BB 7   10
   91        FORMAT(2X,120(1H*)/5X,26HTERM CALLED WITH ARGUMENTS (OCTAL)BB 7   20
     1       10X,2O20/5X,20HNO ACTION TAKEN      /2X,120(1H*))          BB 7   30
           RETURN                                                       BB 7   40
000000000111111111122222222223333333333444444444455555555556666666666777BB 7  130
123456789012345678901234567890123456789012345678901234567890123456789012BB 7  140
END                                                                     BB 7  150
 END                                                                    BB 7  160
$       END                                                             BB 7  170
1     END                                                               BB 7  180
```

SAMPLE OUTPUT

```
     THE DECKS THAT FOLLOW ARE USED MERELY TO INDICATE WHAT IDSEQN DOES          0   0
     AND ARE NOT TO BE CONSTRUED AS ACTUAL PROGRAMS.                             0  10
                                                                                 0  20
     A COPY OF                                                                   0  30
     THE CONTROL CARD FOR THE FIRST JOB FOLLOWS . .                              0  40
                                                                                 0  50
1W    1                                                                          0  60
                                                                                 0  70
     THE ALPHAMERIC FIELD IN COLS. 1-2 WILL BE REPRODUCED ON ALL                 0  80
     PRINTED AND PUNCHED OUTPUT IN COLS. 73-74.                                  0  90
                                                                                 0 100
     THE NON-ZERO DIGIT IN COLUMN 6 INDICATES THAT THE ORIGINAL                  0 110
     IDENTIFICATION FIELD IS TO BE PRINTED UNDER THE NEW FIELD.                  0 120
                                                                                 0 130
                                                                                 0 140
     THE PROGRAM RECOGNIZES ANY LEGAL END CARD AS A SUBROUTINE                   0 150
     TERMINATOR.                                                                 0 160



                                                                            NEW ID.      OLD ID.

      PROGRAM TEST(OUTPUT,INPUT,TAPE5=INPUT,TAPE6=OUTPUT,TAPE20)            1W 0   0     5TS 4  0
C                                                                           1W 0  10
C                                                                           1W 0  20
C                                                                           1W 0  30
   DEMONSTRATION OF OPTION 1                                                1W 0  40
C                                                                           1W 0  50
C                                                                           1W 0  60
C                                                                           1W 0  70
      END                                                                   1W 0  80



                                                                            NEW ID.      OLD ID.

         FUNCTION TERM(A,B)                                                 1W 1   0     2TS 1  0
         PRINT 91,A,B                                                       1W 1  10     2TS 1  1
  91           FORMAT(2X,120(1H*)/5X,26HTERM CALLED WITH ARGUMENTS (OCTAL)1W 1  20     2TS 1  2
   1           10X,2O20/5X,20HNO ACTION TAKEN     /2X,120(1H*))             1W 1  30     2TS 1  3
      DO 1 I=1,100                                                          1W 1  40     2TS 2  4
       J=2*I-1                                                              1W 1  50     2TS 2  5
      CALL STRDTR(STRDTR(STRDTR(0,X(I)),W(J)),W(J+1))                       1W 1  60     2TS 2  6
      CALL SETDTR(2,MADDV(W(J)),MADDV(W(J)),X(I))                           1W 1  70     2TS 2  7
      CALL SETDTR(2,MADDV(W(J)),MADDV(W(J)),W(J))                           1W 1  80     2TS 2  8
    1 CALL SETDTR(-1,-1,4095,W(J+1))                                        1W 1  90     2TS 2  9
      DO 2 I=1,N                                                            1W 1 100     2TS 2 10
    2  M(I)=0                                                               1W 1 110     2TS 2 11
      K=N-2                                                                 1W 1 120     2TS 2 12
      DO 3 I=1,K,2                                                          1W 1 130     2TS 2 13
    3   CALL SETDIR(-1,-1,MADDV(M(I+2)),M(I))                               1W 1 140     2TS 2 14
      RETURN                                                                1W 1 150     2TS 2 16
0000000001111111111222222222233333333334444444444555555555566666666667771W 1 160     77777778
1234567890123456789012345678901234567890123456789012345678901234567890121W 1 170     34567890
                                                                        1W 1 180          END
                                                                     END1W 1 190
```

```
                                                                          NEW ID.      OLD ID.

      FUNCTION NUCELL(A)                                                  1W 2   0     2TS 2  0
      COMMON AVSL                                                         1W 2  10     2TS 2  1
      M=LNKR(AVSL)                                                        1W 2  20     2TS 2  2
         IF(M) 1,2,1                                                      1W 2  30     2TS 2  3
    2 PRINT 901                                                           1W 2  40     2TS 2  4
      STOP                                                                1W 2  50     2TS 2  5
    1 IF (ID(CONT(M))-1) 4,4,3                                            1W 2  60     2TS 2  6
    4    CALL TRANSF(CONT(M+1))                                           1W 2  70     2TS 2  7
    3    CALL SETIND(-1,-1,LNKR(CONT(M)),AVSL)                            1W 2  80     2TS 2  8
         CALL STRIND(0,M)                                                 1W 2  90     2TS 2  9
      CALL STRIND(A,M+1)                                                  1W 2 100     2TS 2 10
         NUCELL=M                                                         1W 2 110     2TS 2 11
      RETURN                                                              1W 2 120     2TS 2 12
  901 FORMAT(1H1,6X,55HLIST OF AVAILABLE SPACE EXHAUSTED - PROGRAM TERM   1W 2 130     2TS 2 13
     1INATED    )                                                         1W 2 140     2TS 2 14
000000000111111111122222222223333333333444444444455555555556666666666777 1W 2 150     77777778
123456789012345678901234567890123456789012345678901234567890123456789012 1W 2 160     34567890
    R  END                                                                1W 2 170
C    5          F    D                                                    1W 2 180
                      FEND                                                1W 2 190
    E  ND                                                                 1W 2 200
  END                                                                     1W 2 210
000000000111111111122222222223333333333444444444455555555556666666666777 1W 2 220     77777778
123456789012345678901234567890123456789012345678901234567890123456789012 1W 2 230     34567890
END                                                                       1W 2 240
$        END                                                              1W 2 250
                                                                        FN1W 2 260     D
              E  ND                                                       1W 2 270




                                                                          0    0
                                                                          0   10
   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...               0   20
                                                                          0   30
TS9  0                                                                    0   40




C                                                                         TS90   0
C                                                                         TS90  10
C                                                                         TS90  20
   DEMONSTRATION OF OPTION 2                                              TS90  30
C                                                                         TS90  40
C                                                                         TS90  50
C                                                                         TS90  60
      END                                                                 TS90  70




         FUNCTION VISIT(A,M)                                              TS91   0
      PRINT 1                                                             TS91  10
 1    FORMAT(30H REFERENCE TO VISIT WAS MADE                 )            TS91  20
      CALL EXIT                                                           TS91  30
         RETURN                                                           TS91  40
000000000111111111122222222223333333333444444444455555555556666666666777TS91  50
123456789012345678901234567890123456789012345678901234567890123456789012TS91  60
      F                                                                   TS91  70
C     END                                                                 TS91  80
    D     E        N           D                                          TS91  90
```

```
      FUNCTION TERM(N,W)                                                TS92   0
      PRINT 91,N,W                                                      TS92  10
  91     FORMAT(2X,120(1H*)/5X,20HTERM CALLED WITH ARGUMENTS (OCTAL)TS92  20
   1      10X,2O20/5X,29HNO ACTION TAKEN      //2X,120(1H*))            TS92  30
      RETURN                                                            TS92  40
    DO 1 I=1,125                                                        TS92  50
     J=2*I-1                                                            TS92  60
    CALL STOPTR(STOPTR(STOPTR(0,X(I)),W(J)),W(J+1))                     TS92  70
    CALL SETPTR(0,MADDV(W(J)),MADDV(W(J)),X(I))                         TS92  80
    CALL SETPTR(2,MADDV(W(J)),MADDV(W(J)),W(J))                         TS92  90
  1 CALL SETPTR(-1,-1,W95,W(J+1))                                       TS92 100
    DO 2 I=1,N                                                          TS92 110
  2  M(I)=0                                                             TS92 120
    K=N-2                                                               TS92 130
    DO 3 I=1,K,2                                                        TS92 140
  3   CALL SETPTR(-1,-1,MADDV(M(I+2)),M(I))                             TS92 150
    CALL SETPTR(0,MADDV(M(N-1)),MADDV(M(1)),AVSL)                       TS92 160
    RETURN                                                              TS92 170
000000000111111111122222222223333333333444444444455555555556666666666777TS92 180
123456789012345678901234567890123456789012345678901234567890123456789012TS92 190
C     END                                                               TS92 200
*     END                                                               TS92 210
*     END                                                               TS92 220
   END                                                                  TS92 230
000000000111111111122222222223333333333444444444455555555556666666666777TS92 240
123456789012345678901234567890123456789012345678901234567890123456789012TS92 250
                                                                  E  ENDTS92 260
      *         ENDN                                                    TS92 270
                                                                        TS92 280
                                                                  END   TS92 290



                                                                           0   0
                                                                           0  10
   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...                0  20
                                                                           0  30
TST4                                                                       0  40



C                                                                      TST40   0
C                                                                      TST40  10
C                                                                      TST40  20
C                                                                      TST40  30
   DEMONSTRATION OF OPTION 3                                           TST40  40
C                                                                      TST40  50
C                                                                      TST40  60
C                                                                      TST40  70
C                                                                      TST40  80
      END                                                              TST40  90



      FUNCTION NULSTR(L,NAD,LNAD)                                      TST41   0
C                                                                      TST41  10
      NULSTR=LIST(0)                                                   TST41  20
      IF (ID(CONT(L,NR2))-2)1,2,1                                      TST41  30
   2     CALL SETID(2,NULSTR,NULSTR,NULSTR)                            TST41  40
      RETURN                                                           TST41  50
000000000111111111122222222223333333333444444444455555555556666666666777TST41  60
123456789012345678901234567890123456789012345678901234567890123456789012TST41  70
   END                                                                 TST41  80
                                                                   END TST41  90
      SUBROUTINE RCELL(CELL)                                            TST42  0
C                                                                       TST42 10
      COMMON AVSL                                                       TST42 20
       CALL SETIND(-1,-1,CELL,LNKL(AVSL))                               TST42 30
      CALL SETDIR(-1,CELL,-1,AVSL)                                      TST42 40
       CALL SETIND(-1,-1,0,CELL)                                        TST42 50
      RETURN                                                            TST42 60
000000000111111111122222222223333333333444444444455555555556666666666777TST42 70
123456789012345678901234567890123456789012345678901234567890123456789012TST42 80
1    0 END                                                              TST42 90


                                                                            0  0
                                                                            0 10
   A COPY OF THE CONTROL CARD FOR THE NEXT DECK FOLLOWS ...                 0 20
                                                                            0 30
TST71                                                                       0 40


C                                                                       TST7  0
C                                                                       TST7 10
C                                                                       TST7 20
   DEMONSTRATION OF OPTION 4                                            TST7 30
C                                                                       TST7 40
C                                                                       TST7 50
C                                                                       TST7 60
      END                                                               TST7 70


      SUBROUTINE RCELL(CELL)                                            TST7  0
C                                                                       TST7 10
      COMMON AVSL                                                       TST7 20
       CALL SETIND(-1,-1,CELL,LNKL(AVSL))                               TST7 30
      CALL SETDIR(-1,CELL,-1,AVSL)                                      TST7 40
       CALL SETIND(-1,-1,0,CELL)                                        TST7 50
      RETURN                                                            TST7 60
000000000111111111122222222223333333333444444444455555555556666666666777TST7 70
123456789012345678901234567890123456789012345678901234567890123456789012TST7 80
1    0 END                                                              TST7 90


          FUNCTION TERM(A,B)                                            TST7  0
          PRINT 91,A,B                                                  TST7 10
   91        FORMAT(2X,120(1H*)/5X,26HTERM CALLED WITH ARGUMENTS (OCTAL)TST7 20
     1       10X,2O20/5X,20HNO ACTION TAKEN      /2X,120(1H*))          TST7 30
           RETURN                                                       TST7 40
000000000111111111122222222223333333333444444444455555555556666666666777TST7 50
123456789012345678901234567890123456789012345678901234567890123456789012TST7 60
END                                                                     TST7 70
 END                                                                    TST7 80
$         END                                                           TST7 90
1      END                                                              TST7 100

JOB COMPLETED
```

COST ESTIMATE

Based on production runs for the CDC 6400, IDSEQN uses approximately 60 seconds of CP time and 60 seconds of PP time for 2500 cards of input data. The CP time can be linearly extrapolated for greater or lesser amounts.

For the job listed on the Sample Input, the total running time was 5.219 seconds for central-processor time and 19.985 seconds for peripheral-processor time with a memory useage of 43,000 words. Chargeable computer time was $1.31.

Charge to user = computer time + postage and handling + network overhead
= $1.31 + $15.00 + network overhead
= $16.31 + network overhead

CONTENTS—IDSEQN

pages

1 Identification & Abstract
3–6 User Instructions
7–13 I/O
15 Cost—Contents

DESCRIPTIVE TITLE	Information-Oriented Language—A Generalized Information and Retrieval System
CALLING NAME	INFOL
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Dr. Jacques Vallee, Control Data Corporation Robert Chalice Department of Industrial Engineering, Northwestern University (CDC 6400 version)
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

INFOL (Information-Oriented Language) is a generalized information storage and retrieval system that permits the user to extract selected pieces of information from a file, presented quickly and conveniently in their original form.

The INFOL language, a subset of English, was designed to be learned and used easily by those without a programming background or a knowledge of computers.

INFOL is a free-field language, thus eliminating the requirement for any part of the language to appear in specific columns of a punched card. Although punched cards are used, the concept of cards as unit records is generally avoided. The concept of an information field, implying limited word size, has been eliminated in INFOL; the user need not be concerned about how many characters to assign any piece of information. All information used as input is treated as a variable-length, but continuous, string of characters. The output may be a printed report or it may be a punched-card deck to be used as input for another computer application.

continued

INFOL includes several basic information-retrieval operations. It first allows the user to store (and later to modify) quantities of data. The system requires no input commands; files of information are established by the user with a single control word, followed by data descriptions and the data. INFOL also facilitates the selection and retrieval of information from the files according to specific requirements (retrieval criteria). The comprehensive examination (interrogation) of stored data, based on efficient retrieval criteria, is the heart of the INFOL system.

REFERENCES

INFOL for the CDC 6400 is based on INFOL as developed by the Control Data Corporation for the CDC 3600/3800 computer. Northwestern University gratefully acknowledges CDC's support in permitting it to utilize INFOL as the basis for the 6400 version and for permission to use the INFOL reference manual number 60170300 to produce its own manual, "INFOL for the CDC 6400—Information Storage and Retrieval System" (Nov. 1968). Support was also given by the U.S. Air Force Office of Scientific Research: "Man-Machine Interaction in Information Retrieval Systems."

USER INSTRUCTIONS

Since the INFOL system is both a language and a processing system, it is necessary for prospective users to obtain the INFOL manual. [1] This document contains all instructions for preparing and submitting input to the system as well as detailed explanations and descriptions regarding optional processing features.

The following pages provide a small amount of information about the system, its general operation, and some salient definitions.

Terminology

The *file* is the largest information unit handled by INFOL, dealing with one subject. A file is made up of *elements*, consisting of data *items* bearing on a single subject. Thus, an employee file would consist of a group of elements (item lists), each element representing one employee. An *item description* defines each item; although usually short, the description may be any length. Elements are of variable length, depending on the items.

The concept of a *multiple item* is a powerful feature of INFOL and should be considered by the user when defining items. A multiple item comprises several *subitems*. The user need not specify a maximum number of subitems, or how many characters are to be reserved for each subitem. (Multiple items are more fully explained in the INFOL manual.)

Initially, when item descriptions are listed, they are followed by their item numbers. For all other steps, such as when actual item values are entered (in the information column), item descriptions are not required. Item numbers are always necessary and must precede all item data, except item descriptions.

Character Set

The INFOL character set is essentially the standard BCD code, with three characters reserved for special use by INFOL: the asterisk and the left and right parentheses. The asterisk is used exclusively as a separator by INFOL; any other use is prohibited. Parentheses have a special application in INFOL, where *logical sets* of retrieval criteria are expressed. However, normal use of parentheses is permitted in comparatively long character strings, such as abstracts, where it is unlikely that a complex criterion would be applied.

continued

Main Phases of INFOL

The four main phases of INFOL are identified by the control words ESTABLISHMENT, INTERROGATION, UPDATE, and REVISION. After the INFOL card, the first text encountered by the system when it scans the input must be one of these control words. Anything else will cause an immediate termination of the run.

Establishment Phase

The file is created in this phase. The items are identified by item descriptions; category, type, and certain other item data are entered. Finally, the information mass that makes up the file is entered and processed. The Establishment Phase is functionally separate from other phases. (For instance, it is not possible to interrogate a file while it is being established.)

Interrogation Phase

This key phase involves two functions: retrieval criteria and extractions. The user specifies conditions (criteria) to be applied to item values in the element. If the criteria are satisfied, items will be extracted according to specifications.

Update Phase

Changes to the elements in the file are made in the Update Phase. Updates are made to a particular element; the element may be modified or removed, or a new element may be entered into the file.

Revision Phase

Items of information may be added to an element, over and above those already defined and established. Before this kind of updating can be done, a Revision pass is necessary to modify the file structure. A Revision pass may also redefine validation criteria, item descriptions, or codes. Revision is also functionally separate from other phases of INFOL.

REFERENCES

1. "INFOL for the CDC 6400—Information Storage and Retrieval System," Ref. Manual, Northwestern Univ. Vogelback Computing Ctr. (revised Nov. 1968).

SAMPLE INPUT

```
VLORR,[redacted],CM110000.   INFOL
LIBRARY(INFOL)
LGO.
INFCL.M
ESTABLISHMENT
ITEM DESCRIPTIONS 26
BIOPSY NO. *1*
CLINIC NO. *2*
DATE RECIEVED *3*
BIOPSY DATE *4*
NAME OF PATIENT *5*
SEX *6*
AGE *7*
RACE *8*
DOCTOR *9*
BIOPSY SITE *10*
BIOPSY SITE (CODE) *11*
DURATION OF LESION *12*
CLINICAL HISTORY *13*
CLINICAL DESCRIPTION *14*
CLINICAL DIAGNOSIS *15*
CLINICAL DIAGNOSIS (CODE) *16*
HISTOPATH DESCRIPTION *17*
HISTOPATH DIAGNOSIS *18*
HISTOPATH DIAGNOSIS (CODE) *19*
HISTOPATH COMMENT *20*
HISTOPATHOLOGIST *21*
SPECIAL STAINS *22*
RECUTS *23*
TEACHING SLIDE *24*
AGE (NUM FORM) *25*
DURATION (NUM FORM) *26*
CATEGORY-TYPE
*1* UNARY NUMERIC
*2* UNARY NUMERIC
*3* UNARY DATE
*4* UNARY DATE
*5* UNARY ALPHANUMERIC
*6* UNARY CODED
*7* UNARY ALPHANUMERIC
*8* UNARY CODED
*9* UNARY ALPHANUMERIC
*10* UNARY ALPHANUMERIC
*11* UNARY ALPHANUMERIC
*12* UNARY ALPHANUMERIC
*13* UNARY ALPHANUMERIC
*14* UNARY ALPHANUMERIC
*15* UNARY ALPHANUMERIC
*16* UNARY NUMERIC
*17* UNARY ALPHANUMERIC
*18* UNARY ALPHANUMERIC
*19* UNARY NUMERIC
*20* UNARY ALPHANUMERIC
*21* UNARY ALPHANUMERIC
*22* UNARY ALPHANUMERIC
*23* UNARY ALPHANUMERIC
*24* UNARY ALPHANUMERIC
*25* MULTIPLE NUMERIC
*26* MULTIPLE NUMERIC
CODES
*6* MNEMONIC M MALE*F FEMALE*
*8* MNEMONIC W WHITE*N NEGRO* O ORIENTAL*
*
VALIDATIONS
*2* INTEGER
*5* ALPHABETIC
```

continued

```
INITIAL INPUT 8
390     *1* 390 *2* 23687 *3* 8-30-68 *4* 8-27-68 *5* PHIL BRUNZ *6* M *7* 53 *8
390     * W *9* SMITH *10* RIGHT HAND    *11* 24918 *12* 2 YRS. *13* QUIESCENT L
390     ESION ARISING WITHOUT TRAUMA TWO YEARS AGO. ASYMPTOMATIC. *14* A THREE-M
390     ILLIMETER NODULAR LESION WITH A VERRUCA SURFACE. HYPERPIGMENTED. *15* DE
390     RMATOFIBROMA  *16* 2460  *17* THERE IS MODERATE HYPERKERATOSIS AND IRREG
390     ULAR ACANTHOSIS. WITHIN THE DERMIS ONE NOTES A SEPARATION OF COLLAGEN AN
390     D YOUNG FIBROBLASTS FOLLOWING A SOMEWHAT PARALLEL VESICULAR ARRANGEMENT.
390     AT THE PERIPHERY ONE SEES TRAPPING OF COLLAGEN. *18* DERMATOFIBROMA  *19
390     * 2460 *21* WAC *22* PAS. COLOIDAL IRON *25* 53*0*0
390     *0* *26* 2*0*0*0**
390

                      .               .                .
                      .               .                .
                      .               .                .

742290  *1* 742290*3* 7/3/68 *5* 80 OG *6* M *7* 12 *8* W *9* GA *10* UPPER ABDO
742290  MEN*11* 3784 *12* YEARS *13* MULTIPLE PIGMENTED LESIONS ON BODY. *14* 3
        TO 5MM                                                                  S
742290  HAPED PIGMENTED LESIONS. *15* INTRADERMAL NEVI *16* 3351 *17* THE EPI
742290  DERMIS SHOWS SOME ELONGATION OF THE RETE RIDGES ALTHOUGH IN GENERAL IT I
742290  S THINNED. WITHIN THE UPPER PORTION OF THE DERMIS PARTICULARLY WITHIN TH
742290  E DERMAL PAPILLAE ONE SEES SHEETS OF CELLS WHICH ARE EPITHELIOID IN CHAR
742290  ACTER. SOME OF THESE CELLS ARE PIGMENTED. THESE SHEETS EXTEND DEEPLY INT
742290  O THE DERMIS AND IN THIS AREA A MORE SPINDLE SHAPED CELL PREDOMINATES. S
#42290  UPERFICALLY THERE IS CONSIDERABLE TELANGIECTASIA AND A FEW SCATTERED GIA
742290  NT CELLS. THERE WAS NO EVIDENCE OF DERMAL INVASION.
742290  *18* SPINDLE AND EPITHEILOID CELL NEVUS.   COMMENT= THIS LESION IS ALSO
742290  CALLED JUVENILE MELANOMA. *19* 1323 *21* WAC *25* 32*0*
742290  0*0* *26* 2*0*0*0**
INTERROGATIONS
RETRIEVAL CRITERIA 1
*1* EQ 634890
EXTRACTIONS 1
*1* REPORT
*3* REPORT
*5* REPORT
*14* REPORT
*15* REPORT
RETRIEVAL CRITERIA 2

                      .               .                .
                      .               .                .
                      .               .                .

RETRIEVAL CRITERIA 6
*3* GT JAN 1 ,1968
*10* EQ TRUNK
*25* LT 40
*17* EQ HISTIOCYTES
EXTRACTIONS 6
REPORT ALL

RETRIEVAL CRITERIA 7
 *6* EQ M
EXTRACTIONS 7 TABULAR
*1* REPORT
*5* REPORT
*6* REPORT
*7* REPORT
```

SAMPLE OUTPUT

(This part of the output is merely a relisting of the input file structure.)

```
INFCL.M

          .
          .
          .
                ELEMENT       390 ACCEPTED
                ELEMENT     23790 ACCEPTED
                ELEMENT    235890 ACCEPTED
                ELEMENT    386590 ACCEPTED
                ELEMENT    473290 ACCEPTED
                ELEMENT    634890 ACCEPTED
                ELEMENT    639690 ACCEPTED
                ELEMENT    742090 ACCEPTED
                ELEMENT    742190 ACCEPTED
                ELEMENT    742290 ACCEPTED


INFCL2                                                                03/22/69
NUMBER OF ELEMENTS IN FILE..    10

                          - MAXIMUM SIZES OF ALL VARIABLE LENGTH INFORMATION -

     ITEM DESCRIPTION        ITEM  CATEGORY   A    TYPE      FIELD     NUMBER OF   NUMBER  OF   FRACTION     NON-FRACTION
                             NO.              GRP            LENGTH    SUB-ITEMS   CARDS        CHARACTERS   CHARACTERS

BIOPSY NO.                    1    UNARY           NUMERIC      6                                             6
CLINIC NO.                    2    UNARY           NUMERIC      5                                             5
DATE RECIEVED                 3    UNARY           DATE        14
                              .                    .             .
                              .                    .             .
                              .                    .             .
AGE (NUM FORM)               25    MULTIPLE        NUMERIC      3          4                     0            1
DURATION (NUM FORM)          26    MULTIPLE        NUMERIC      4          4                     1            4


                          VALIDATION CRITERIA                                 03/25/69

  ITEM DESCRIPTION     ITEM NC.     NECESSARY  TYPE    MAXIMUM    CHARACTERS          RANGE

CLINIC NO.                 2                   INTEGER
NAME OF PATIENT            5                   ALPHABET
```

continued

```
INFOL2   RETRIEVAL REPORT NO.   1                                        03/25/69                          PAGE   1

*1* EQ 634890
EXTRACTIONS 1
*1* REPORT
*3* REPORT
*5* REPORT
*14* REPORT
*15* REPORT

-------------------------------------------------------------------------------------------------------------------

  6 BIOPSY NO.            634890
    DATE RECIEVED          1/SEP/1968
    NAME OF PATIENT       GECRGE JOHNSON
    CLINICAL DESCRIPTION  EXTENSIVE ERUPTION OF THREE TO FIVE MOL. BLUISH-RED NODULES OVER CHEST , BACK , TRUNK AND EXTREMITIE
                          S. A FEW ARE ALSO PRESENT IN THE SCALP.
    CLINICAL DIAGNCSIS    METASTATIC CARCINOMA

-------------------------------------------------------------------------------------------------------------------


         NUMBER OF ELEMENTS WHICH SATISFY THIS SEARCH REQUEST =     1

-------------------------------------------------------------------------------------------------------------------

RETRIEVAL CRITERIA 2
```

⋮ ⋮ ⋮

continued

```
RETRIEVAL CRITERIA 6

 INFOL2   RETRIEVAL REPORT NO.   6                                    03/25/69                                  PAGE    6

*3* GT JAN 1 ,1968
*10* EQ TRUNK
*25* LT 40
*17* EQ HISTIOCYTES
EXTRACTIONS 6
REPORT ALL

------------------------------------------------------------------------------------------------------------------------

  5 BIOPSY NO.                          473290
    CLINIC NO.                          36824
    DATE RECIEVED                       25/AUG/1968
    NAME OF PATIENT                     SAM SMI
    SEX                                 M
    AGE                                 32
    RACE                                N
    DOCTOR                              CARO
    BIOPSY SITE                         TRUNK
    BIOPSY SITE (CODE)                  7092
    DURATION OF LESION                  2.5 MONTHS
    CLINICAL HISTORY                    PATIENT HAS HAD A GENERALIZED ERYTHEMATOUS ERUPTION FOR THREE MONTHS , LESIONS NONPRURITIC
                                        . SOME HAVE ULCERATED.
    CLINICAL DESCRIPTION                GENERALIZED ERYTHEMATOUS MACULOPAPULAR LESIONSSOME OF WHICH SHOW CENTRAL ULCERATION. THESE
                                         LESIONS ARE ANESTHETIC.
    CLINICAL DIAGNOSIS                  RULE OUT LEPROSY
    CLINICAL DIAGNOSIS (CODE)           1616
    HISTOPATH DESCRIPTION               INITIAL SECTIONS SHOW THE EPIDERM IS TO BE MODERATELY ACANTHOTIC AND A MOLD LYMPHOCYTIC IN
                                        FILTRATE WITHIN THE DERMIS. NO OTHER PATHOLOGIC FEATURES ARE NOTED. IN THE RECUTS HOWEVER
                                        , ONE SEES A PROLIFERATION OF FOAMY HISTIOCYTES WITH WIDELY SPACED NUCLEI. THERE IS A GREN
                                        Z ZONE SEPARATING THIS INFILTRATE FROM THE EPIDERMIS. IN OTHER AREAS THERE IS A MORKED PRO
                                        LIFERATION OF PLASMA CELLS , HISTIOCYTES AND A FEW GIANT CELLS. A FITE STAIN REVEALED THE
                                        PRESENCE OF NUMEROUS ACID FAT BACILLI AND A BROWN-BRENN STAIN SHOWED A FEW GRAM POSITIVE O
                                        RGANISMS.
    HISTOPATH DIAGNOSIS                 LEPROMATOUS LEPROSY
    HISTOPATH DIAGNOSIS (CODE)          1616
    HISTOPATHOLOGIST                    MAC
    SPECIAL STAINS                      FITE-FARACO , BROWN-BRENN , PAS , GIEMSA , WAR THIN-STARRY
    RECUTS                              YES
    TEACHING SLIDE                      YES
    AGE (NUM FORM)                      32
                                        0
                                        0
                                        0
    DURATION (NUM FORM)                 0
                                        2.5
                                        0
                                        0

------------------------------------------------------------------------------------------------------------------------


            NUMBER OF ELEMENTS WHICH SATISFY THIS SEARCH REQUEST =      1

------------------------------------------------------------------------------------------------------------------------
```

continued

```
RETRIEVAL CRITERIA 7


 INFOL2   RETRIEVAL REPORT NO.   7                        03/25/69                 PAGE    7

 *6* EQ M
EXTRACTIONS 7 TABULAR
*1* REPORT
*5* REPORT
*6* REPORT
*7* REPORT

------------------------------------------------------------------------------------------

     BIOPSY NO.  NAME OF PATIENT       SEX         AGE

------------------------------------------------------------------------------------------

  1     390      PHIL BRUNZ             M           53
  2   23790      FRED NURDLEY           M           90
  4  386590      JOE CROWFOOT           M           73
  5  473290      SAM SMITH              M           32
  6  634890      GEORGE JOHNSON         M           70
  8  742090      T JONES                M           32
  9  742190      L SLOAN                M           32
 10  742290      BC OG                  M           32

           NUMBER OF ELEMENTS WHICH SATISFY THIS SEARCH REQUEST =     8

------------------------------------------------------------------------------------------

INFOL EXECUTION TERMINATED NORMALLY
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 16.216 seconds for central-processor time and 51.212 seconds for peripheral-processor time with a memory useage of 110,000 words. Chargeable computer time $4.18.

Charge to user = computer time + postage and handling + network overhead

= $4.18 + $15.00 + network overhead

= $19.18 + network overhead

CONTENTS—INFOL

pages
1,2 Identification & Abstract
3,4 User Instructions
5-10 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Linear Programming
CALLING NAME	LINPROG NUCC120
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	School of Business, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

LINPROG will solve any linear-programming problem with a maximum of 125 variables and 75 constraint equations. It utilizes the original (two-phase) simplex method for solving linear-programming problems and uses a *minimizing* objective function. To solve a maximizing problem, the signs on the objective function coefficients must be reversed before usage.

USER INSTRUCTIONS

Description of Input Data

The input to the program consists of three types of data.

1. a parameter card
2. a specification of the initial basis
3. a set of matrix elements

Before keypunching the data onto cards, it is necessary to put the original problem into *standard* form. For example, starting with a set of constraints and an objective function to be minimized, one must perform the following operations—

1. make all righthand sides of the constraint expressions (the B values or requirements vector) *positive* or zero
2. convert all inequalities to equalities by use of +1 or -1 slack variables
3. put the objective function in the last row of the matrix
4. put the requirements vector or B values in the first column of the matrix
5. place all other elements, including slack and artificial variables, in the remaining N-1 columns of the matrix

For example, if the original problem is

Maximize $4X_1 - 8X_2 + 3X_3 + 12X_4 - X_5$

Subject to $X_1 - 3X_2 + 4X_3 + 2X_4 + 11X_5 \geq -10$

$7X_1 + 2X_2 + 5X_4 - X_5 \geq 4$

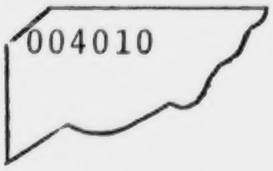
$3X_1 - 5X_2 + X_3 + 4X_4 + 2X_5 = 14$

when put into standard form and entered properly into the matrix (using detached coefficients) will appear as follows.

Col.	1	2	3	4	5	6	7	8	9	10	
Row	Values	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	
1	10	-1	3	-4	-2	-11		1			
2	4	7	2		5	-1	-1		1		Matrix Elements
3	14	3	-5	1	4	2				1	
4		-4	8	-3	-12	1					Obj. Func. Row

continued

When the matrix has been laid out, the *input-data cards* are prepared as follows. First, the *parameter card* consists of the integers M and N, each 3 digits, where M is the number of rows in the matrix (≤ 76) and N is the number of columns in the matrix (≤ 126). In this example, the 4X10 matrix would appear on the parameter card starting in Col. 1 as follows.



Second, following the parameter card will be a series of cards that will define the *initial basis* and specify the artificial variables, if any. Each element in the identity matrix is specified by row (3 digits that start in card Col. 1), matrix column number (3 digits), and, if this element is an artificial variable, a 1 is punched in Col. 9 of the card. So, the three basis cards (in any order) for our problem would be

```
001008
002009001
003010001
```

Third, all *nonzero* matrix elements are punched, one per card, in this format: row number (3 digits, which start in Col. 1), column number (3 digits), and the matrix element value (F10.2 format). The order of these cards is not important but for one exception: the *last element* of the matrix *must be punched whether it is zero or not and must be the last card in the deck of input data*. In our example, some of the cards would appear as

```
001001+10
001002-1
002002+7
004003+8
003010+1
002007-1
001004-4
    :
    :
004010 0. (last element)
```

Description of Output

The program will provide the following information—

1. a printout of the initial tableau is given. The data in this matrix should correspond directly to the linear-programming problem offered for solution

continued

2. the variables that have been declared artificial are listed
3. intermediate output is given for each iteration in the form

```
ITNO 5 IN X(9)  OUT S(3)   -Z MIN = 9.7856
```

4. a printout of the final tableau is given
5. if a feasible optimum solution has been found for the problem represented in the INITIAL TABLEAU, a summary of the results will be printed along with the following message

```
OPTIMUM FEASIBLE SOLUTION FOUND, -ZMIN = 2342.07
```

Error Indications

If the problem is unfeasible, either one of the following two error messages will appear

```
SOLUTION IS UNBOUNDED
```

or

```
ARTIFICIAL VARIABLES CANNOT BE SUPPRESSED
```

Limitations

The program is able to handle 125 variables and 75 constraint equations. Elements are read in under F10.2 format and printed out under F12.4 format.

Multiple Problems

Any number of problems may be solved sequentially by merely stacking the problem data decks.

Job Deck Structure

```
Job Card
LIBRARY(LINPROG)
LGO.
7-8-9 (EOR card)
      Parameter card           ]   (may be repeated for any number
      Initial basis cards      ]   of problems)
      Set of matrix elements   ]
6-7-8-9  (EOI card)
```

SAMPLE INPUT

```
VLORR.CH[redacted],CM60200.    LINPROG
LIBRARY(LINPROG)
LGO.
'  END OF RECORD
015024
001015001
002002
003003
004004
005005
006006
007007
008008
009009
010010
011011
012012
013013001
014014001
001001+010.
001015+001.
001018-001.
001023+001.
001024+001.
002001+800.00
002002+001.00
002019+024.00
002021+040.00
002023+020.00
003001+800.00
003003+001.00
003020+024.00
003022+040.00
003024+020.00
004001500.00
004004+001.00
004019+600.00
004021+070.00
004023+040.00
005001500.00
005005+001.00
005020+600.00
005022+070.00
005024+040.00
0060011500.
006006+001.
006019+180.
     .
     .
     .
002003 1.
002005 1.
003001 2.
003002-1.
003003 -1.
003006 1.
004001 1.
004002-1.
004003 -2.
004007 1.
005001 3.
005002-2.
005003 -3.
005008 1.
006002 -2.
006003 -1.
006008
015024-040.00
'  END OF INFORMATION
```

SAMPLE OUTPUT

```
                              INITIAL TABLEAU

   BASIS      VALUES       X(  1)       X(  2)       X(  3)       X(  4)
  X( 14)     10.0000      -1.0000       2.0000       1.0000       0.0000
  X(  1)      6.0000      -1.0000       1.0000       0.0000       1.0000
  X(  2)      2.0000      -1.0000      -1.0000       0.0000       0.0000
  X(  3)      1.0000      -1.0000      -2.0000       1.0000       0.0000
  X(  4)      3.0000      -2.0000      -3.0000       0.0000       1.0000
  X(  5)   1500.0000      -2.0000      -1.0000       0.0000       0.0000
  X(  6)   1500.0000       0.0000       0.0000       0.0000       0.0000
  X(  7)    600.0000       0.0000       0.0000       0.0000       0.0000
  X(  8)    600.0000       0.0000       0.0000       0.0000       0.0000
  X(  9)     30.0000       0.0000       0.0000       0.0000       0.0000
  X( 10)    120.0000       0.0000       0.0000       0.0000       0.0000
  X( 11)    150.0000       0.0000       0.0000       0.0000       0.0000
  X( 12)     10.0000       0.0000       0.0000       0.0000       0.0000
  X( 13)     20.0000       0.0000       0.0000       0.0000       0.0000
    -Z        0.0000       0.0000       0.0000       0.0000       0.0000
                 .            .            .            .            .
                 .            .            .            .            .
                 .            .            .            .            .

               X( 20)       X( 21)       X( 22)       X( 23)
               0.0000       0.000        1.0000       1.0000
              40.0000       0.0000      20.0000       0.0000
               0.0000      40.0000       0.0000      20.0000
              70.0000       0.0000      40.0000       0.0000
               0.0000      70.0000       0.0000      40.0000
              10.0000       0.0000      15.0000       0.0000
               0.0000      10.0000       0.0000      15.0000
              30.0000       0.0000      25.0000       0.0000
               0.0000      30.0000       0.0000      25.0000
               0.0000       0.0000       0.0000       0.0000
               1.0000       1.0000       0.0000       0.0000
               0.0000       0.0000       1.0000       1.0000
               0.0000       0.0000       0.0000       0.0000
               1.0000       1.0000       0.0000       0.0000
             -91.0000     -94.0000     -51.0000     -40.0000


IF ANY, THE ARTIFICIAL VARIABLES ARE...
    X( 14)
    X( 12)
    X( 13)

         ITNO    0    IN X(  0)     OUT X(  0)   -ZMIN=        0.000000
         ITNO    1    IN X(  2)     OUT X( 14)   -ZMIN=        0.000000
         ITNO    2    IN X( 18)     OUT X(  3)   -ZMIN=        7.067500
         ITNO    3    IN X( 19)     OUT X(  4)   -ZMIN=       15.608500
         ITNO    4    IN X( 20)     OUT X(  1)   -ZMIN=       16.150812
         ITNO    5    IN X( 21)     OUT X(  2)   -ZMIN=       21.347849
         ITNO    6    IN X(  1)     OUT X( 13)   -ZMIN=     1875.825812
         ITNO    7    IN X( 16)     OUT X(  8)   -ZMIN=     2419.143468
         ITNO    8    IN X(  5)     OUT X( 12)   -ZMIN=     5712.875436
         ITNO    9    IN X( 15)     OUT X(  6)   -ZMIN=     5961.080149
         ITNO   10    IN X( 22)     OUT X(  7)   -ZMIN=     5980.014105
         ITNO   11    IN X(  9)     OUT X(  9)   -ZMIN=     5987.890333
         ITNO   12    IN X(  4)     OUT X( 16)   -ZMIN=     5995.631717

                .        .                 .        .
                .        .                 .        .
                .        .                 .        .
```

continued

```
                          FINAL TABLEAU

BASIS     VALUES      X(  1)      X(  2)      X(  3)      X(  4)
X(  2)   946.7381     0.0000      1.0000       .1634      0.0000
X( 20)     2.2034     0.0000      0.0000      0.0000      0.0000
X( 21)    17.7966     0.0000      0.0000      0.0000      0.0000
X( 18)     4.0402     0.0000      0.0000       .0011      0.0000
X( 19)     7.3446     0.0000      0.0000      0.0000      0.0000
X(  5)  3034.7232     0.0000      0.0000      -.8683      0.0000
X( 15)     1.4248     0.0000      0.0000       .0011      0.0000
X( 22)    19.8371     0.0000      0.0000      -.0004      0.0000
X(  4)   278.8236     0.0000      0.0000      -.8557      1.0000
X(  9)    10.5752     0.0000      0.0000      -.0011      0.0000
X( 10)   100.0000     0.0000      0.0000      1.0000      0.0000
X( 11)   130.1129     0.0000      0.0000       .0004      0.0000
X(  5)  1663.9659     0.0000      0.0000      -.5101      0.0000
X(  1)  1703.3634     1.0000      0.0000      -.6736      0.0000
  -Z    5095.6317     0.0000      0.0000       .4096      0.0000

          X( 10)      X( 11)      X( 12)      X( 13)      X( 14)
          0.0000      0.0000      0.0000     -2.3058       .1683
          0.0000      0.0000      0.0000      1.0000      0.0000
          0.0000      0.0000      0.0000      0.0000      0.0000
          0.0000      0.0000      0.0000      -.0553      -.0006
          0.0000      0.0000      0.0000      0.0000      0.0000
          0.0000      0.0000      0.0000     11.8695      -.5658
          0.0000      0.0000     -1.0000      -.0553      -.0006
          0.0000      0.0000      0.0000     -1.1801       .0002
          0.0000      0.0000      0.0000    -18.5563      -.8221
          0.0000      0.0000      0.0000       .0553       .0006
          1.0000      0.0000      0.0000     -1.0000      0.0000
          0.0000      1.0000      0.0000      1.1801      -.0002
          0.0000      0.0000      0.0000     -8.0976      -.4949
          0.0000      0.0000      0.0000     -5.7917      -.6632
          0.0000      0.0000      0.0000      -.5152      -.2048

          X( 20)      X( 21)      X( 22)      X( 23)
          0.0000      0.0000      0.0000      8.6176
          1.0000      0.0000      0.0000      -.8220
          0.0000      1.0000      0.0000       .8220
          0.0000      0.0000      0.0000       .0897
          0.0000      0.0000      0.0000       .0377
          0.0000      0.0000      0.0000      8.7425
          0.0000      0.0000      0.0000       .1273
          0.0000      0.0000      1.0000       .9542
          0.0000      0.0000      0.0000     20.2179
          0.0000      0.0000      0.0000      -.1273
          0.0000      0.0000      0.0000      0.0000
          0.0000      0.0000      0.0000       .0458
          0.0000      0.0000      0.0000     12.0218
          0.0000      0.0000      0.0000     17.1895
          0.0000      0.0000      0.0000     34.9777
```

continued

```
        SUMMARY OF RESULTS

  BASIS          ACTIVITY   NON-BASIS   OPPORTUNITY
VARIABLES         LEVEL     VARIABLES      COST
 X(  1)         1723.3044     --            --
 X(  2)          846.7441     --            --
   --               --      X(  3)         .4096
 X(  4)          278.8346     --            --
 X(  5)         3034.7242     --            --
   --               --      X(  6)        3.4510
   --               --      X(  7)         .3280
   --               --      X(  8)        2.3654
 X(  9)           16.5752     --            --
 X( 10)          100.0000     --            --
 X( 11)          136.1129     --            --
   --               --      X( 12)        0.0000
   --               --      X( 13)        -.5152
   --               --      X( 14)        -.2048
 X( 15)            1.4248     --            --
   --               --      X( 16)         .5152
   --               --      X( 17)         .2048
 X( 18)            6.0002     --            --
 X( 19)            7.3445     --            --
 X( 20)            2.2734     --            --
 X( 21)           17.7466     --            --
 X( 22)           10.4471     --            --
   --               --      X( 23)       39.9777

    OPTIMUM FEASIBLE SOLUTION FOUND. -ZMIN=      5995.631717

NOTE-
    THIS PROGRAM FORCES ALL MATRIX ELEMENTS LESS THAN OR EQUAL TO
    0.000001 TO ZERO.  WHERE IMPORTANT, RE-SCALING THE COEFFICIENTS
    WILL AVOID ANY LOSS IN ACCURACY.
```

.   .   .
.   .   .
.   .   .

COST ESTIMATE

For the job listed on the Sample Input, the elapsed computer time was 1.697 seconds of central-processor time and 12.885 seconds of peripheral-processor time with a memory useage of 60,200 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—LINPROG

pages

1 Identification
3–5 User Instructions
7–10 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Multivariate Analysis of Variance
CALLING NAME	MANOVA NUCC170
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Biometrics Laboratory, University of Miami
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

MANOVA performs univariate and multivariate analyses of variance, of covariance, and of regression. It provides an exact solution in either the orthogonal or nonorthogonal case. Options include single- or multiple-degree-of freedom contrasts in the main effects or interactions, transformations of variables, and orthogonal polynomial contrasts with equally or unequally spaced points. Reanalyses may be done with different criteria, covariates, contrasts, and models.

REFERENCES

Bock, R.D., "Programming Univariate and Multivariate Analysis of Variance," Technometrics 5, 95–117 (1963).

Graybill, F.A., *An Introduction to Linear Statistical Models* (McGraw-Hill Book Co., Inc., New York, 1961), Vol. 1, pp. 223--253.

Rao, C.R., *Advanced Statistical Methods in Biometric Research* (John Wiley & Sons, Inc., New York, 1952), pp. 236–272.

Roy, S.N., *Some Aspects of Multivariate Analysis* (John Wiley & Sons, Inc., New York, 1957), pp. 76–86.

USER INSTRUCTIONS

Preparation of Data

In the following descriptions of cards, when capital letters are used under the heading *Contents*, those actual letters should be punched in the columns specified.

The program expects cards in the following sequence.

Title Cards

Columns	*Contents*
1–5	TITLE
6–80	Title to be printed on output (any alphnumeric characters) (As many additional title cards may be used as desired, each with the letters TITLE punched in Cols. 1–5)

Problem Card

Columns	*Contents*
1–4	PROBLEM
6–7	Total number of variables, right-justified (maximum 40). Any number of these may be used as criteria or covariates in a given analysis
8	Number of factors (maximum 8). This is the total number of ways of classification. Blocking factors are included, as are replication factors if they are main effects in the design
9	Blank: standard data-card format The level codes should be in one-digit fields, beginning in Col. 3, and the variables in 10 six-digit fields, beginning in Col. 13 If variable format is used, this column shows the number of Variable-Format Cards to be read
10	Blank: program will identify variables on output by consecutive numbers 1: variable names are supplied
11	Blank: all variables are used as criteria in the initial analysis 1: a subset of the variables is to be used as criteria. This should be punched if some of the variables are covariates

continued

Columns	*Contents*
12	Blank: standard ordering of significance tests. This assumes that the design is a complete factorial with a within-cells error term and that only tests of overall main effects and interactions are obtained. This is ordinarily used for orthogonal designs where the order of elimination of confounding is irrelevant. This is also used for a one-cell design—regression analysis, canonical correlation, T^2. In this latter case, there should be only one contrast card indicating one level 1: Significance-Test Cards are read in to specify the model and the effects tested
13	Blank: residual effect is not to be tested 1: last effect on Significance-Test Cards is to be obtained as residual and tested
14	Blank: correlations between observed error variables and canonical variables not to be printed 1: correlations are to be printed
15	Blank: input data located on cards 4: input data located on alternate tape (logical tape 4). Only the data cards described below can be on tape 4. The Control Cards (including this one) must still be on cards
16	Blank: cell means are to be printed 1: cell means are not to be printed
17	Blank: no transformations of data 1: transformations of data are to be computed
18	Blank: reduced-model matrix is not to be printed 1: reduced-model matrix is to be printed This will be the reduced matrix corresponding to the contrasts specified on the Contrast Cards, and the effects specified on the Significance-Test Cards
19	Blank: correlations among model parameters are not to be printed 1: correlations are to be printed. For the typical factorial design with equal numbers of observations in the cells, this matrix will be orthogonal across effects, but within effects there will be correlations unless single-degree-of-freedom orthogonal contrasts have been used

continued

Columns	*Contents*
20	Blank: reduced-model matrix is not read in 1: reduced-model matrix is read in and tested according to Significance-Test Cards. Column 12 must contain a 1 punch for this option. The Significance-Test Cards are necessary to specify the effect names and the degrees of freedom for successive effects
21	Blank: general mean is included first in model and is not tested 1: general mean is omitted from the model or is indicated on the Significance-Test Card. Column 12 must contain a 1 punch for this option

Variable-Name Cards (optional)

If these cards are included, the Problem Card, Col. 10, should contain a 1 punch.

Columns	*Contents*
1–10	Name of first variable (any alphanumeric characters)
11–20	Name of second variable
⋮	⋮
71–80	Name of eighth variable. Continue on as many additional cards as necessary. The total number of names must equal the number of variables

Variable-Subset Cards (optional)

If these cards are included, the Problem Card, Col. 11, should contain a 1 punch.

Columns	*Contents*
1–2	Number of criteria used in this analysis, right-justified
3–4	Number of covariates, right-justified
5–80	The variables can be thought of as numbered from I to V, where V is the total number of variables. In these columns, punch the variable numbers for each of the criteria, followed by the variable numbers of each of the covariates, in 2-digit fields. If there are more than 38 variables, continue the variable numbers on another card, beginning in Cols. 1–2

continued

Contrast Cards

A Contrast Card is entered for every factor in the design. The order is the same as the order in which the factor codes are punched in the data cards, from left to right. For example, a Contrast Card for factor A followed by a Contrast Card for factor B would indicate that, in the data cards, the code for factor A is to the left of that for factor B.

Several types of contrasts may be used, depending upon the type of analysis desired. The regular contrasts are the customary deviations of row and column means from the grand mean and the generalizations of these for the interaction contrasts. These will typically be used when only the overall tests of significance are required.

When single-degree-of-freedom contrasts are desired or subgroupings of degrees of freedom, the Special-Contrasts Option is taken and the specific contrasts in main effects to be tested are entered. Ordinarily these will be orthogonal contrasts. When nonorthogonal contrasts are used, the ordering of the single-degree-of-freedom contrasts should be carefully considered. Interaction contrasts may also be tested, and these are interpreted as contrasts in contrasts. For example, if we have a contrast in factor A of 1 –1 and a contrast in factor B of 2 –1 –1, the interaction contrast will be 2 –1 –1 –2 1 1.

Another type of contrast frequently encountered is the orthogonal polynomial contrast. Contrasts may be computed within the program either for the case of equally spaced points or unequally spaced points. Only the metric (a set of numbers that indicates the spacing) is required. A typical case for a 5-level factor might be numbers 1, 2, 5, 10, 20.

The difference contrasts are a useful orthogonal set. They have the form

$$\begin{array}{ccccc}
1 & 1 & 1 & 1 & 1 \\
-1 & 1 & 0 & 0 & 0 \\
-\frac{1}{2} & -\frac{1}{2} & 1 & 0 & 0 \\
-\frac{1}{3} & -\frac{1}{3} & -\frac{1}{3} & 1 & 0 \\
-\frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & -\frac{1}{4} & 1
\end{array}$$

They should always be used for nested factors with unequal group size.

continued

The letter specified on the Contrast Cards is used to construct the effect names. A single letter always refers to a single factor, with degrees of freedom equal to the number of levels minus one. Letters in combination with other letters always refer to interactions with appropriate degrees of freedom. For the purpose of referring to individual degrees of freedom or groups of degrees of freedom, a partitioning must be specified and the degrees of freedom for each partition indicated. If we think of a matrix of contrasts, the first partition refers to the contrasts at the top of the matrix and the last partition refers to the contrasts at the bottom. All the degrees of freedom in a factor must be accounted for in the partitions, and up to eight partitions may be specified. For orthogonal polynomial contrasts, the first partition will include the linear effect, and later partitions will include the higher effects. To refer to a given partition, one uses the letter identification of the factor in combination with a digit to indicate the number of the partition. For example, A5 indicates the fifth partition of the factor A. Since only a single letter is used to identify each factor, it is desirable to write a more complete description of the factor in Cols. 61–80 of the Contrast Card and this is printed on the output listing.

Columns	*Contents*
1	Letter indentification of factor (any letter except W)
2	Blank: regular contrasts (deviation contrasts) 1: special contrasts (to be read in on special contrast cards immediately following this Contrast Card) 2: orthogonal polynomial contrasts (requires metric to be read in on Special Contrast Card immediately following this Contrast Card) 3: orthogonal comparisions of level i+1 minus average of previous levels (difference contrasts)
3–4	Number of levels for this factor, right-justified (maximum 20)
5–20	Blank: no partition of this factor If the factor is to be partitioned, in these columns punch the degrees of freedom for each partition in 2-digit fields. These 16 columns allow room for eight partitions of the factor. If any partitioning is done, all degrees of freedom must be accounted for
21–60	Blank; level codes are punched in data cards in consecutive order beginning with 1 If the level codes are not in consecutive order in the data cards, in these columns punch the level codes

continued

Columns	*Contents*
	that do appear in the data cards, in 2-digit fields. These 40 columns allow room for 20 levels of the factor.
61–80	Name of this factor (any alphanumeric characters)

Special-Contrast Cards (optional)

These must immediately follow any Contrast Card that contains a 1 or 2 punched in Col. 2.

When entering the special-contrast matrix, the first row is used to give weights that specify how other factors are to be averaged over the given factor. These weights will ordinarily be 1. In an experiment in which the population contained twice as many values of level 1 as of level 2 for a factor A, it might be desirable to use the weights 2 and 1. In averaging a factor B over A, twice as much weight would be given to those cells in which B occurred with A1 as compared to B in conjunction with A2.

Columns	*Contents*
1–80	For special contrasts (signified by a 1 punch in Col. 2 of the preceding Contrast Card), these cards contain a square matrix with as many rows as there are levels in the factor, in 5-digit fields. The first row is punched in the first Special-Contrast Card and gives weighting factors that are ordinarily 1. Each of the subsequent rows begins on a new card that contains the special contrasts desired for each degree of freedom; they must sum to zero For orthogonal polynomials (signified by a 2 punch in Col. 2 of the preceding Contrast Card), only the metric is specified, in 5-digit fields

Significance-Test Cards (optional)

If these cards are included, the Problem Card, Col. 12, should contain a 1 punch.

The factors are indicated by the letters read in on the Contrast Cards. If A and B are factors, A and B designate main effects and AB designates the interaction of A and B. Higher-order interac-

continued

tions are indicated in the same way, for example, ABC. Order is irrelevant so that AB=BA. Subeffects are indicated as A1, A2, A3 for up to eight subeffects. The degrees of freedom are taken from the successive partitions in the Contrast Cards. If A1 and B2 are subeffects A1B2 is their interaction.

AWC and ABWC indicate that the effects A and AB are nested within C. AWBC indicates A nested within both B and C. Subeffects and their interactions may be used as the nested effect, for example, A1B2WC. AWB5C10 indicates A nested within the fifth level of B and the tenth level of C. This is the only case in which numbers refer to levels.

AB+A+C indicates a lumped effect. Any effects may be lumped.

In what follows, any combination of the above is considered an effect. E=1 designates E as error term 1, where E is any effect. Up to eight special error terms may be used. Below, — means a minus sign.

E=0: the effect E is not to be tested.

E-1: the effect E is to be tested against error term 1.

E-0: E is to be tested against the residual-error term.

E-9: E is to be tested against the lumped within- and residual-error term.

If the error term is not specified, it is assumed to be the within-cells error if there is any, otherwise the residual.

The general mean is ordinarily ordered first in the model matrix and is not tested. It may be put anywhere and tested by so indicating on the Problem Card and indicating its error term as above but using a blank to signify the mean—for example, b—9. Degrees of freedom of all effects are computed from the levels of the main effects. For the residual, it is computed by subtraction.

It is sometimes convenient (for example, for interaction tables) to specify models in terms of cell means. The W notation described above, when preceded by a blank rather than a factor code, may be used for this purpose. bWAB specifies the ABC interaction table. It is essential that the option to leave the grand mean out of the model be taken when this device is used. Note that A, B, and AB are completely confounded with WAB and must not be included in the model. Other effects such as blocking factors should ordinarily be included. It is preferable to use a separate reanalysis (with estimates only) for each interaction table.

continued

For some designs, particularly those with vacant cells, it is most convenient to obtain the last effect as a residual from the between-cells sums of products and to obtain its degrees of freedom in the same way. The Significance-Test Cards must include the specification for all effects, but the last effect will have a dummy name as far as computations are concerned. It must, however, be a valid name. *Example:* 2-factor experiment with vacant cells but no completely vacant rows or columns. A,B,AB.

Columns	*Contents*
1–80	Code letters for effects of the design are punched in the order of elimination of confounding, typically main effects first and interactions last. The code letters begin in Col. 1 and are separated by commas. After the final effect, punch a period. The only imbedded blanks allowed are those signifying the mean or preceding a W as explained above. *Example:* B,A,AB. Continue on additional cards if necessary.

Variable-Format Cards (optional)

If one or more of these cards are included, the Problem Card, Col. 9, should be punched with the number of Variable-Format Cards.

Columns	*Contents*
1–80	Variable format for one subject (must begin and end with parentheses and include a level code for each factor in I1 or I2 format). Continue on as many additional Variable-Format Cards as needed.

Transformation Card (optional)

If this card is included, the Problem Card, Col. 17, should contain a 1 punch.

Columns	*Contents*
1	Blank: no transformation for first variable 1: square-root transformation for first variable 2: $\log_e$ transformation for first variable 3: arc sine transformation for first variable 4–9: user's transformation for first variable The user has the option of inserting from one to six transformations of his own and indicating which he wants applied to the first variable by means of these

continued

Columns	*Contents*
	code numbers. To insert your own transformation, it is necessary to change a FORTRAN statement in SUBROUTINE SPECTR and recompile it. Comments included in that FORTRAN subroutine give detailed instructions.
2	Transformation code for second variable (same code as punched in Col. 1 for first variable). Continue with as many columns as there are variables.

Data Cards

First comes the numerical level code for the first factor, then the level codes for additional factors if there are any, followed by the subject's score for the first variable, his score for the second variable, and so on. The columns must conform to the variable-format statement or to the standard format if that option is specified in the Problem Card, Col. 9.

All of the Data Cards for one subject must be together in order, but the subjects may be read in any order. In other words, all of the subjects in one cell need not be together.

Put one or more blank cards after the last Data Card: if each subject has one Data Card, include one blank card; if each subject has several Data Cards, include the same number of blank cards.

Reduced-Model-Matrix Cards (optional)

If these cards are included, the Problem Card, Col. 20, must contain a 1 punch.

Columns	*Contents*
1–80	First row of the reduced-model matrix, punched in 5-column fields in F format
	Continue on as many additional cards as there are rows in the reduced-model matrix

Reanalysis Card (optional)

This card is used to indicate reanalyses using the previous data and a subset of the variables, or new contrasts, or new Significance-Test Cards.

continued

Columns	*Contents*
1–5	ANALY
6	Blank: all variables are used as criteria in this analysis 1: a subset of the variables is to be used as criteria
7	Blank: previous significance tests are used, or if new contrasts are specified, standard ordering for complete factorial 1: Significance-Test Cards are read in
8	Blank: previous contrasts are used 1: new contrasts are specified for this analysis
9	Blank: residual effect is not to be tested 1: last effect on Significance-Test Cards is to be obtained as residual and tested
10	Blank: reduced-model matrix is not read in 1: reduced-model matrix is read in and tested according to Significance-Test Cards. Column seven must contain a 1 punch for this option
11	Blank: general mean is included first in model and is not tested. 1: general mean is omitted from the model or is indicated on the Significance-Test Card. Column seven must contain a 1 punch for this option
12	1: only estimates of effects are to be printed Printout of reduced-model matrix and correlations of parameters is suppressed for this and succeeding analyses

Variable-Subset Cards (optional)

If these cards are included, the Reanalysis Card, Col. 6, should contain a 1 punch. The contents of these cards it the same as previously described under the same heading.

Contrast Cards and Special-Contrast Cards (optional)

If these cards are included, the Reanalysis Card, Col. 8, should contain a 1 punch. The contents of these cards is the same as previously described under the same headings.

Significance-Test Cards (optional)

If these cards are included, the Reanalysis Card, Col. 7, should contain a 1 punch. The contents of these cards is the same as previously described under the same heading.

continued

Reduced-Model Matrix Cards (optional)

If these cards are included, the Reanalysis Card, Col. 10, should contain a 1 punch. The contents of these cards is the same as previously described under the same heading.

Additional reanalyses may follow, each beginning with a Reanalysis Card.

Additional problems may follow, each beginning with a Title Card.

Finish Card

This card should be placed at the end of all analysis-of-variance problems.

Columns	*Contents*
1–6	FINISH

Description of Output

1. Description of problem including listing of Title Cards, number of variables and factors, names of variables, names of criteria and covariates, names of factors with levels of each and type of contrasts, degrees of freedom in the subgroups of each factor
2. (Optionally deleted.) Cell means, unbiased standard deviations, and number of observations identified by cell (labeled MEANS AND STANDARD DEVIATIONS)
3. Reduced-model matrix (optional)
4. Correlations of effects (optional)

Univariate Analysis

5. For a univariate analysis, a single ANOVA table is printed. Each error term is followed by the test of regression if there are any covariates, and the hypotheses tested against that error term. These tests are adjusted for any covariates. The estimates of the effects in the complete model and any regression coefficients follow. The estimates are adjusted for any covariates ($a - \Sigma\beta_i a_i$).

continued

Multivariate Analysis

The following are obtained for each error term for which a significance test is indicated.

6. Error correlations of variables
7. Estimates of effects that are tested against this error term. The estimates are adjusted for any covariates $(a - \Sigma\beta_i a_i)$
8. Analysis of regression if there are any covariates. For each error term used, an analysis of regression is obtained, eliminating all ANOVA parameters. An overall test of significance is obtained, using Wilk's lambda criterion (likelihood-ratio test). The approximate F test uses Rao's approximation. An approximate test is also given for the remaining roots after eliminating the first, second, third, etc. The error canonical correlations between the variates and the covariates are printed and also the univariate F tests for regression appropriate to each criterion variable eliminating all the covariates. The standardized discriminant functions are printed corresponding to the canonical weights for the criteria in a canonical correlation problem. They differ in that they are standardized by the adjusted-error standard deviations rather than by the raw-score deviations.
9. For each effect tested, a page with the multivariate and univariate tests is obtained. The multivariate test is Wilk's lambda criterion, using Rao's approximate F test. The canonical correlations are those between the criteria and the artificial ANOVA variables. Tests are adjusted for any covariates. The univariate F tests follow and then the standardized discriminant function coefficients. These coefficients may be interpreted as weights in a discriminant-function problem. In fact, for a one-way analysis of variance with two levels, they are the ordinary two-group discriminant functions. For more than two groups, they are the coefficients that give the maximum variation between groups relative to that within groups. Additional orthogonal discriminant functions are given for any roots significant at the 0.15 level. For analysis of covariance, the discriminant functions are standardized by the adjusted-error standard deviations.

Note that the order of effects in the multivariate printout is exactly the opposite of that indicated on the Significance-Test Cards; that is, for the conventional analysis, the highest-order interaction is printed first and, if it were tested, the mean would be printed last. Notice also that each test eliminates effects listed before it on the Significance-Test Cards and ignores effects listed afterwards; that is, we can consider this

continued

to be a test of a linear model in stages where, at each stage, we test the higher-order term, and, if we decide that it is null, proceed to the next lower order, assuming that the higher-order term is null. For an orthogonal analysis, any order of effects will give the same results, but for a nonorthogonal analysis, this is not so.

Limitations

1. No more than a total of 40 variables, which includes criteria plus covariates
2. No more than 100 nonvacant cells in the design
3. Up to eight factors may be accommodated, with a maximum of 20 levels in each
4. No limitation on the number of subjects. The number in various cells may be unequal
5. If a score is missing for a variable (blank or minus zero on the Data Card), it will be detected and that subject will be omitted from the analysis

Sample Job Deck

```
JOB Card
REQUEST(TAPE4)  HANG REEL XXXX
  (If data are on tape)

LIBRARY(MANOVA)

LGO.
7-8-9
  Title Cards
  Problem Card
  Variable-Name Cards (optional)
  Variable-Subset Cards (optional)
  Contrast Cards
  Special-Contrast Cards (optional)
  Significance-Test Cards (optional)
  Variable-Format Cards (optional)
  Transformation Card (optional)
  Data Cards
  Reduced-Model Matrix Cards (optional)
  Reanalysis Card (optional)
    Variable-Subset Cards (optional)
    Contrast Cards and Special-Contrast Cards (optional)
    Significance-Test Cards (optional)
    Reduced-Model Matrix Cards (optional)
  Additional problems may follow, each beginning with a Title Card.
  FINISH Card
```

SAMPLE INPUT

```
'SEQUENCE,NU532748
VLORR[redacted],CM107700.    MANOVA
LIBRARY(MANOVA)
LGO.
'  END OF RECORD
TITLE PROBLEM 1 FROM HALL AND CRAMER MANOVA PROGRAM WRITTEN IN FORTRAN II
TITLE 2X2 FACTORIAL DESIGN WITH 6 CRITERIA
TITLE REANALYZE WITH 1 CRITERION AND 5 COVARIATES
PROB  6211   1    11
       ONE         TWO     THREE       FOUR       FIVE        SIX
A  2                                                             ALPHA
B  2                                                             BETA
(2I1,10X,6F6.0)
115    41      569.  156.  104.  506.  4.     9.
115    42      475.  120.  105.  366.  4.     16.
115    43      641.  83.   82.   815.  4.     16.
115    44      779.  104.  104.  331.  4.     17.
115    45      587.  98.   53.   564.  3.     13.
        .                  .                .
        .                  .                .
        .                  .                .
229    88      748.  96.   65.   601.  4.     10.
229    89      763.  135.  92.   480.  2.     12.
229    90      578.  102.  65.   683.  3.     -8.

ANALY1
 1 5 5 1 2 3 4 6




FINISH
'END OF INFORMATION
```

SAMPLE OUTPUT

```
        VOGELBACK COMPUTING CENTER
        NORTHWESTERN UNIVERSITY

        M A N O V A - -  MULTIVARIATE ANALYSIS OF VARIANCE




                 PROBLEM 1 FROM HALL AND CRAMER MANOVA PROGRAM WRITTEN IN FORTRAN II
                 2X2 FACTORIAL DESIGN WITH 6 CRITERIA
                 REANALYZE WITH 1 CRITERION AND 5 COVARIATES



 6 VARIABLES  2 FACTORS

        ONE          TWO      T   HREE          FOUR         FIVE          SIX

 6 CRITERIA   0 COVARIATES  WITH THE FOLLOWING VARIABLES
        ONE          TWO      T   HREE          FOUR         FIVE          SIX

FACTOR A    2 LEVELS            ALPHA
  DEVIATION CONTRASTS

FACTOR B    2 LEVELS            BETA
  DEVIATION CONTRASTS

FORMAT OF DATA CARDS
   (2I1,10X,6F6.0)

  4 CELLS

                                        MEANS AND STANDARD DEVIATIONS


FACTOR                                       VARIABLE
  A  B                            ONE          TWO      T   HREE        FOUR         FIVE          SIX
  1  1          10 OB
                         M      685.100     115.400      91.700     494.200        4.000        9.300
                        SD      153.122      30.497      46.094     133.073         .667        8.367
  1  2          10 OB
                         M      658.900     102.900      68.900     494.100        3.700       11.900
                        SD      130.096      17.760      16.868      74.866         .483        9.927
  2  1          10 OB
                         M      668.500      96.300      65.800     490.100        2.800       12.300
                        SD      183.563      19.889      11.717     108.459        1.033        7.134
  2  2          10 OB
                         M      646.900      91.300      59.200     480.200        3.300        7.900
                        SD      119.088      20.769      14.172     116.118         .823        6.757

NATURAL ORDER OF EFFECTS


                           REDUCED MODEL MATRIX


FACTOR                            PARAMETER
  A  B                    1          2          3          4
  1  1                  1.000      1.000      1.000      1.000
  1  2                  1.000      1.000     -1.000     -1.000
  2  1                  1.000     -1.000      1.000     -1.000
  2  2                  1.000     -1.000     -1.000      1.000
```

continued

```
CORRELATIONS OF CONTRASTS WITH STANDARD DEVIATIONS OF CONTRASTS DIVIDED BY STANDARD DEVIATIONS OF VARIABLES ON DIAGONAL


CONTRAST         1            2             3             4
   1                .158
   2                .000        .158
   3                .000       0.000         .158
   4                .000       0.000        0.000          .158


WITHIN CELLS CORRELATIONS OF CRITERIA WITH STANDARD DEVIATIONS ON DIAGONAL ADJUSTED FOR  0 COVARIATES


VARIABLE                 ONE          TWO        THREE         FOUR          FIVE          SIX
     ONE             148.533
     TWO               -.063       22.762
   THREE               -.171         .633       26.208
    FOUR                .080        -.122         .021      110.182
    FIVE                .295        -.122         .076         .074          .778
     SIX               -.097        -.054        -.261        -.117         -.440         8.141


ESTIMATES ADJUSTED FOR  0 COVARIATES


                                               CRITERIA
CONTRAST                      ONE              TWO       T    HREE             FOUR             FIVE             SIX
A
      1                     7.150            7.675           8.900            4.500             .400             .250
B
      1                    11.950            4.375           7.350            2.500            -.050             .450
AB
      1                     1.150            1.875           4.050           -2.450             .200           -1.750


AB
TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION   AND CANONICAL CORRELATIONS
TEST OF ROOTS              F          DFHYP        DFERR     P LESS THAN      R
 1 THROUGH  1            .557         6.000        31.000         .761         .312


                          UNIVARIATE F TESTS                STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS
VARIABLE            F( 1,   36)      MEAN SQ      P LESS THAN       1
     ONE                .002         52.900          .951         -.167
     TWO                .271        140.625          .606          .169
   THREE                .955        656.100          .335          .222
    FOUR                .020        240.100          .889         -.135
    FIVE               2.642          1.600          .113          .744
     SIX               1.848        122.500          .182         -.327
```

continued

```
B

TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION   AND CANONICAL CORRELATIONS
TEST OF ROOTS                  F         DFHYP       DFERR    P LESS THAN     R
 1 THROUGH  1               .726        6.000      31.000        .632        .351


                      UNIVARIATE F TESTS                  STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS
VARIABLE           F( 1.    36)    MEAN SQ    P LESS THAN       1
      ONE                 .259    5712.100        .614         .510
      TWO                1.478     765.625        .232        -.098
    THREE                3.146    2160.900        .085        1.052
     FOUR                 .021     250.000        .847         .051
     FIVE                 .165        .100        .687        -.267
      SIX                 .122       8.100        .729         .362


A

TESTS OF SIGNIFICANCE USING WILKS LAMBDA CRITERION   AND CANONICAL CORRELATIONS
TEST OF ROOTS                  F         DFHYP       DFERR    P LESS THAN     R
 1 THROUGH  1              3.286        6.000      31.000        .013        .624


                      UNIVARIATE F TESTS                  STANDARDIZED DISCRIMINANT FUNCTION COEFFICIENTS
VARIABLE           F( 1.    36)    MEAN SQ    P LESS THAN       1
      ONE                 .093    2044.900        .763        -.123
      TWO                4.348    2356.225        .040         .487
    THREE                4.613    3168.400        .039         .188
     FOUR                 .067     810.000.       .798         .110
     FIVE               11.569       6.400        .002         .998
      SIX                 .038       2.500        .847         .558


DISCRIMINANT SCORES
CONTRAST                                                            1
     1                                                           .757


CORRELATIONS BETWEEN VARIABLES AND COMPOSITE SCORES
VARIABLE                                                            1
      ONE                                                        .064
      TWO                                                        .446
    THREE                                                        .449
     FOUR                                                        .054
     FIVE                                                        .679
      SIX                                                        .041

REANALYSIS WITH THE FOLLOWING   1 CRITERIA AND    5 COVARIATES
     FIVE            ONE            TWO      T   HREE            FOUR          SIX


SOURCE                        SS        DF           MS             F            P LESS THAN

WITHIN CELLS              15.453        31         .498
REGRESSION                 6.347         5        1.269          2.546             .048
A                          5.849         1        5.849         11.734             .002
B                           .097         1         .097           .195             .662
AB                          .614         1         .614          1.232             .276


ESTIMATES ADJUSTED FOR   5 COVARIATES
```

continued

```
                                                   CRITERIA
CONTRAST                          FIVE
A
      1                          .417
B
      1                         -.052
AB
      1                          .128


RAW REGRESSION COEFFICIENTS

COVARIATES           WITHIN    CELLS
        ONE                      .001
        TWO                     -.008
      THREE                      .005
       FOUR                     -.000
        SIX                     -.037

ABOVE NOT TITLE CARD

END OF DATA
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 2.455 seconds for central-processor time and 48.294 seconds for peripheral-processor time with a memory usage of 107,700 words. Chargeable computer time was $1.91.

Charge to user = computer time + postage and handling + network overhead

= $1.91 + $15.00 + network overhead

= $16.91 + network overhead

CONTENTS—MANOVA

pages

pages	
1	Identification & Abstract
3–15	User Instructions
17–21	I/O
23	Cost—Contents

DESCRIPTIVE TITLE	95X95 Factor Analysis with Varimax Rotation
CALLING NAME	MESA1 NUCC016
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorrain Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

MESA1 can correlate, factor, and rotate a maximum of 95 variables. The maximum sample size that can be used with the program is 32 768 observations. Sample size should be larger than number of variables.

MESA1 is composed of three parts: a main program, an eigenvalue subroutine, and a varimax-rotation subroutine. The eigenvalues are calculated by a modified Jacobian method that closely parallels the routine given by Greenstadt in the Ralston and Wilf volume.[1] The varimax subroutine is from BIMD17 package and is based on the Kaiser algorithm.[2] The method of principal-components orthogonal rotation is used.

All of the output of the program is in the form of naturally arranged tables. The variables in the tables can be labeled by name as well as by number. The output of the program can include

—means, standard deviations, the third and fourth moments of each variable

—the standard errors of each of the above

continued

—triangular matrix of product moment correlation coefficients, with communality estimates in the main diagonal

—a table of positive eigenvalues, with percentages and cumulative percentages based upon both the total variance of the matrix and the variance accounted for by the factors to be rotated

—matrix of rotated factors

—matrix of unrotated factors. (The number of factors included in this and subsequently listed output is subject to the restrictions explained in the following section.)

The program has the following options available, which are determined by Control-Card entries.

A. Input and Communality Options

The input to the program can be either a series of $N (N < 32\ 768)$ observations of M variables each $(M \leq 95)$ or a MXM correlation matrix. If the input is in the form of observations, the following communality options can be computed for each variable X_i

1. All l's
2. Squared multiple correlation of X_i with the remaining X_j, $i \neq j$
3. Absolute value of the largest correlation of X_i with X_j, $i \neq j$

If a matrix input is used, only the following options are avaiable for communality estimate for variables X_i

4. All l's
5. Absolute value of largest correlation of X_i with X_j
6. The diagonal element r_{ii} *in the data input matrix*

No factor scores are available with options 4, 5, and 6. In these cases, Cols. 36–37 of the Problem Card *must* be blank.

B. Rotation Options

1. Rotation is optional and can be suppressed
2. If rotation is not suppressed, the following series of conditions and options determines the number of variables that will be rotated. (These conditions also determine the number of factors included in the factor matrix.)

The following conditions always hold

a. A maximum of *19 factors* can be rotated

b. Only factors with *positive eigenvalues* can be rotated

continued

c. A maximum of 100% of the communality of the original matrix can be accounted for by factors. (In practice, this condition means that, if the first k largest factors account for 100% of the original variance, then *no addition* factors will be calculated.)

The largest number of factors that can be rotated is the minimum of the three values determined by the above conditions. The number of factors to be rotated can be *further* restricted by the following options.

d. Specification of a *maximum number of factors*

e. Specification of the *minimum eigenvalue* to be included among rotated factors. (This specification can be a constant, or can be evaluated as the absolute value of the largest negative eigenvalue)

f. Specification of a *minimum/maximum-factor loading* for factors to be included in the rotation. (In practice, this option means that it is possible to exclude from rotation any factors that have no loadings at or above the specified value. This option should be used with caution because the program will stop calculating factors at the *first* factor that fails this maximum-factor-loading criterion. It sometimes happens that a factor will fail this min/max test when a factor with a smaller eigenvalue would not fail it.)

If any of the communality options d, e, or f are used, the minimum value, so determined, serves as the limit on the number factors to be rotated, if that value is less than the value determined by condition a, b, and c. The options d, e, and f can be suppressed by leaving the appropriate Control-Card columns blank.

REFERENCES

1. Greenstadt, J., "The Determination of the Characteristic Roots of a Matrix by the Jacobi Method," in *Mathematical Methods for Digital Computers*, Ralston and Wilf, Eds. (John Wiley & Sons, Inc., New York, 1959), Chap. 7.

2. Kaiser, H.F., "The Varimax Criterion for Analytical Rotation in Factor Analysis," Psychometrika *23*, No. 3 (Sept. 1958).

USER INSTRUCTIONS

Data Options

Input in the form of observations. The variables for each observation are located on one or more cards for that observation. The arrangement of the variables on these cards is limited only by the requirement that such arrangement can be expressed in not more than eight Variable-Format Cards. One or more columns of the Data Card(s) for each observation must precede or follow the actual data. These columns are used only for identification and may be blank; a corresponding A-format specification for these columns *must* be included in the Variable-Format Card(s).

Input in matrix form. The program reads a full MXM matrix, including diagonals, one row at a time. There are one or more cards for each row; each row must begin on a new card. The Variable-Format Card(s) specify the variables in each row; no identification and no corresponding A-format specification is allowed here, unlike A in paragraph above.

Program-Control Cards

1. Problem Cards

Columns	
1– 6	Problem name, any 6 alphanumeric characters except finish
7– 9	Number of variables (up to 95)
11–15	Sample size, number of observations; sample size must be less than or equal to 32 768 (may be left blank if input is the R matrix)
16–17	Input and communality options Data Input 01 Program puts ones in diagonal 02 Program puts sqrd mult R in diagonal 03 Program puts largest row R in diagonal Matrix Input 04 Program puts ones in diagonal 05 Program puts largest row R in diagonal 06 No diagonal calculations; diagonals are used as read from cards
18–21	Lower limit for eigenvalues to be included in rotation. This value is read as F4.2; that is, Cols. 20

continued

	and 21 are read as decimal positions; 1.35 would be punched as 0135 (may be left blank if this limit is not desired)
22–24	Minimum/maximum-factor loading, limiting the factors to be rotated. This value is read as F3.2; 0.25 would be punched as 025 (may be left blank if this limit is not wanted)
26–27	Upper limit on the number of factors to be rotated (may be left blank if this limit is not wanted)
29	Number of Variable-Format Cards (must be less than or equal to 8)
30–31	Rotation control Blank, if rotation is desired 01, if no rotation
36–37	Blank: no factor scores punched 10: unrotated factor scores punches 01: rotated factor scores punched 11: both factor scores punched *Note:* No factor scores are available when a matrix input is used. In this case, Cols. 36–37 must remain blank.
38–39	Blank: identification precedes data 01: identification follows data

2. Page-Heading Cards

The information punched in Cols. 1–72 of the first card and the information in Cols. 1–54 of the second card will be printed as a single line at the top of each page of the program output. (If no heading is wanted, 2 blank cards *must* be used.)

3. Variable-Name Cards

The number of name cards required is equal to the integral value of [(NV - 1)/12] + 1, where NV is the number of variables in the problem.

Columns 1–72 of the name cards are read—Cols. 1–6 are used for the name of the first variable; Cols. 7–12 are used for the name of the second variable, etc.

continued

The names should be ordered on the cards as follows

	Columns	
Card 1:	1– 6	Name of 1st variable
	7–12	Name of 2nd variable
	⋮	
	67–72	Name of 12th variable
Card 2 (if required):	1– 6	Name of 13th variable
	7–12	Name of 14th variable

If variable names are not wanted, blank cards *must* be used.

4. Variable-Format Card(s) (N cards, N < 8, where N is specified in Col. 29 of the problem card)

The variables are read with F- or E-type specifications. In additions, the Variable-Format Card(s) must have an A-type specification preceding or following the variable specifications, when using data option above. This is for the purpose of reading the corresponding identification field for each observation; this field is *not* included in the variable count of Cols. 7–9 of the Problem Card.

5. Finish (End-of-Job) Card

Columns	
1– 6	FINISH

This card must be included after the last Data Card of the last problem to be processed.

Required Subprogram

None

Limitations

Number of variables	≤ 95
Number of observations	≤ 32 768
Number of Variable-Format Cards	≤ 8
Number of rotated variables	≤ 15

continued

Job Deck Structure

```
LIBRARY(MESA1)
LGO.
7-8-9 EOR
        (Program-Control Cards and data decks)
        Problem Card (1 card)
        Page-Heading Cards (2 cards)
        Variable-Name Cards
        Format Cards
        Deck of input data
        Finish (End-of-Job) Card
6-7-8-9 EOI
```

If more than one problem is being processed in a single computer run, then the cardsshould be ordered in the following sequence.

```
System cards (see above)
        Problem Card             1st problem
        Page-Heading Cards       1st problem
        Variable-Name Cards      1st problem
        Format Cards             1st problem
        Data deck                1st problem

        Problem Card             2nd problem
        Page-Heading Cards       2nd problem
        Variable-Name Cards      2nd problem
        Format Cards             2nd problem
        Data deck                2nd problem
            .                    .
            .                    .
            .                    .

        Format Cards             Last problem
        Data deck                Last problem

        FINISH Card
```

SAMPLE INPUT

```
VLORR,CH[redacted],CM77200.    MESA1
LIBRARY(MESA1)
LGO.
'  END OF RECORD
LEE S  30       050100       1
FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R
AND E VALUES OF 1.00 -- DONE BY HOLMES
1      2      3      4      5      6      7      8      9      10     11     12
13     14     15     16     17     18     19     20     21     22     23     24
25     26     27     28     29     30
(15 F 5.3 / 15 F 5.3)
 1000-0102-0094 0010 0110-0198-0043-0056 0286-0312-0330-0052 0019 0071-0054  011
 0168 0102-0029 0029-0256-0075-0074 0074 0044-0036-0077-0061 0012 0113-0059  012
-0102 1000 0422-0171-0362 0013 0045-0111-0235 0282 0060-0249 0253-0379-0275  021
-0193-0176-0159 0218 0260-0153 0111-0135 0100-0137 0073 0082-0051-0154-0089  022
-0094 0422 1000-0199-0272-0102-0076-0010-0207 0272-0089-0262 0406-0415-0298  031
-0204-0230-0138 0324 0220-0136 0121-0181 0048-0013 0110 0147-0172-0295-0084  032
                .                   .                 .
                .                   .                 .
                .                   .                 .
 0012-0051-0172 0183 0103 0016 0119-0170 0004-0131 0069 0082-0048 0002 0058  281
 0144 0261 0057-0095-0104-0120-0092 0082 0115-0096-0059-0010 1000 0788-0066  282
 0113-0154-0295 0175 0138 0036 0041-0116 0068-0225 0126 0098-0076 0120 0018  291
 0209 0296 0086-0163-0241-0112-0025 0047 0087-0146-0079-0076 0788 1000-0118  292
-0059-0089-0084 0119 0004-0109-0135 0095 0044-0048-0157 0021-0052 0106 0147  301
 0053-0005 0038-0049 0058 0176-0255 0264-0172 0038 0026-0047-0066-0118 1000  302
FINISH
'  END OF INFORMATION
```

SAMPLE OUTPUT

```
FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES
        FACTOR ANALYSIS
        PROBLEM NAME                              LEE S
        NUMBER OF FORMAT CARDS                        1
        NUMBER OF VARIABLES                          30
        SAMPLE SIZE                                  -0
        ROTATION                                    YES
        COMMUNALITIES                             MAX R
        MINIMUM EIGENVALUE TO ROTATE               1.00
        MIN-MAX FACTOR LOADING TO ROTATE          -0.00
        MAXIMUM NUMBER FOR ROTATION                  -0

FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES
                                           MATRIX TO BE FACTORED
VARIABLE
NO.  NAME      1       2       3       4       5       6       7       8       9      10      11      12

 1  1        .330
 2  2       -.102    .422
 3  3       -.094    .422    .422
 4  4        .010   -.171   -.199    .340
 5  5        .110   -.362   -.272    .146    .373
 6  6       -.198    .013   -.102   -.151   -.232    .321
 7  7       -.043    .045   -.076   -.228    .026    .025    .228
 8  8       -.056   -.111   -.010   -.056   -.262   -.001   -.182    .262
 9  9        .286   -.235   -.207    .126    .109   -.118   -.102   -.208    .326
10 10       -.312    .282    .272   -.276   -.373   0.000   -.083    .181   -.326    .414
11 11       -.330    .060   -.089   -.172   -.267    .321    .107    .198   -.202    .140    .330
12 12       -.052   -.249   -.262    .131    .162    .060   -.050   -.202   -.038   -.304   -.253    .304

                               .               .               .
                               .               .               .
                               .               .               .
```

continued

```
 VARIABLE
NO.  NAME        25         26         27         28         29         30

25 25           .280

26 26           .004       .200

27 27           .193       .108       .225

28 28          -.096      -.059      -.010       .788

29 29          -.146      -.079      -.076       .788       .788

30 30           .038       .026      -.047      -.066      -.118       .264


 FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES
      TABLE OF POSITIVE EIGENVALUES

                                   PERCENT OF COMMUNALITY OVER
      NO.   EIGENVALUE     ALL (  30) FACTORS       5 ROTATED FACTORS

       1       4.070          34.3    34.3          41.1     41.1
       2       2.010          16.9    51.2          20.3     61.4
       3       1.529          12.9    64.1          15.4     76.8
       4       1.215          10.2    74.3          12.3     89.1
       5       1.078           9.1    83.4          10.9    100.0
       6        .801           6.8    90.2
       7        .700           5.9    96.1
       8        .623           5.2   101.3
       9        .545           4.6
      10        .416           3.5
      11        .358           3.0
      12        .292           2.5
      13        .226           1.9
      14        .196           1.7
      15        .164           1.4
      16        .142           1.2
      17        .029            .2
      18        .014            .1

      TRACE OF ORIGINAL MATRIX          11.872
      COMMUNALITY OVER  30 FACTORS =    11.872
                         5 FACTORS =     9.903


 FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES

                           UNROTATED   FACTOR  MATRIX

               FACTOR NUMBER        1          2          3          4          5          6          7          8
 SUM SQUARES OVER VARIABLES      4.070      2.010      1.529      1.215      1.078       .801       .700       .623

  VARIABLE    COMMUNALITY
 NO.  NAME     8 FACTORS


  1  1           .377             .225       .090      -.231      -.357      -.114       .278      -.216      -.020
  2  2           .432            -.532       .059       .101      -.256       .211      -.102       .064       .100
  3  3           .498            -.580      -.087      -.030      -.350       .079      -.115       .053       .089
                                    .                     .                     .
                                    .                     .                     .
                                    .                     .                     .
```

continued

```
28  28        .790        .303     .651     .386    -.097    -.132    -.109     .294    -.005
29  29        .771        .401     .697     .305    -.009    -.137    -.015     .103     .053
30  30        .205        .164    -.345     .119    -.067    -.094     .039     .104     .139


  FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES

                                ROTATED   FACTOR  MATRIX

                  FACTOR NUMBER        1        2        3        4        5
SUM SQUARES OVER VARIABLES         2.980    1.974    1.971    1.655    1.324

  VARIABLE   COMMUNALITY
 NO.  NAME     5 FACTORS


 1   1        .253        .013     .113     .008    -.470     .136
 2   2        .407       -.514    -.201    -.048     .164     .270
 3   3        .474       -.600    -.304    -.037    -.016     .142
                      .            .            .
                      .            .            .
                      .            .            .


 FACTOR ANALYSIS OF PERSONALITY VARIABLES (40) ON WOMEN USING LARGEST R  AND E VALUES OF 1.00 -- DONE BY HOLMES


                 PROBLEM IS FINISHED

28  28        .592        .037     .779    -.008     .082     .276
29  29        .758        .173     .807    -.084     .056     .257
30  30        .173        .056    -.064     .350    -.089    -.187
```

COST ESTIMATE

The sample program exhibited was run with 30 variables. For the job listed on the Sample Input, the total running time was 12.017 seconds for central-processor time and 22.995 seconds for peripheral-processor time with a memory usage of 77,200 words. Chargeable computer time was $2.36.

Charge to user = computer time + postage and handling + network overhead
= $2.36 + $15.00 + network overhead
= $17.36 + network overhead

CONTENTS—MESA1

pages
1–3 Identification & Abstract
5–8 User Instructions
9–12 I/O
13 Cost—Contents

DESCRIPTIVE TITLE	Northwestern University Cross Classification and Tabulation
CALLING NAME	NUCROS NUCC017
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Betty Benson Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

NUCROS is a general program for preparing crossclassifications (also called *crosstabulations* or *contingency tables*) in two, three, or four dimensions. For all tables, it is also possible to obtain row and column percentages, chi square, Kendall's tau, the Goodman-Kruskal gamma, and Somers D. A maximum of 99 problems may be executed in one run; each run is able to produce up to 72 tables from a given set of Control Cards and data. Data input may be from cards or tape. For each problem, a maximum of 9999 cases, with up to 80 variables/case, may be processed. The input data must be of the integer type; however, they may be recoded.

REFERENCES

Janda, K., *Data Processing* (Northwestern University Press, Evanston, Ill., 1968), 2nd ed.

Bonato, R. R., and Waxman, B. D., "A General Cross-Classification Program for Digital Computers," Behavioral Sci. *6*, No. 4, 347–357 (Oct. 1961).

USER INSTRUCTIONS

The preparation of a data deck for NUCROS necessitates the following program Control Cards.

Problem Card (Card 1)

Columns	*Contents*
1,2	Number of problems to be executed (number of times that NUCROS will be executed)

Title Cards (Cards 2,3)

Columns	*Contents*
1–72	Alphanumeric title or other identifying information (may be blank, but must be included in the Control-Card deck)

Main-Parameter Card (Card 4)

Columns	*Contents*
1– 4	Number of cases to be read and processed (maximum 9999). If the number of cases is unknown, punch any number that is greater than the maximum expected and exercise the EOFOK option (Cols. 29, 30 of this card). Program will then read in data until it reaches an end of file
5,6	Number of variables to be read (maximum 80)
7,8	Number of tables to be prepared (maximum 72). A 3- or 4-dimensional output consists of a series of subtables but is counted as one table only, with respect to the number punched in this field, as well as with respect to the maximum of 72

For the options described below, *any number larger than zero punched in the appropriate control field will exercise the option; if the control field is punched zero or left blank, the option will be bypassed.* (Yes *is represented by any number greater than zero and* no *by any zero or blank.)*

Columns	*Contents*
9–10	Variable-Name Option—permits the labelling of each table with an alphanumeric description of each variable. [The program obtains the descriptions from information punched into Cols. 1–72 of the Variable-Name Cards (see below), one for each variable, ordered according to the sequence

continued

of the variables on the data cards. If this variable-name feature is desired, then one Variable-Name Card for each variable to be read must follow the Control Cards and come before the Data Cards]

11–12 Variable-Recording Option—enables variables to be recorded by addition, subtraction, or division by any number less than 100. It also permits 1- to 5-digit data to be regrouped into intervals of specified size. (See Recode-Control Cards, below)

13–14 Data-Tape Option—permits the data to be read from a separate data tape instead of from cards (recommended for large numbers of cases)

15–16 Data-Tape-Rewind Option—[used only in conjunction with the Data-Tape Option (Cols. 13–14)] causes the separate data tape to rewind after each execution of the program. (This permits the user to handle more than 80 variables or to prepare more than 72 tables for one computer run with the same data)

17–18 Chi-Square Option—causes chi-square values and the contingency coefficient to be computed for each table and subtable. (The zero-row and zero-column frequencies are omitted from these calculations)

19–20 Column-and-Row-Percentages Option—causes two additional tables to be printed for each contingency table, the first containing the percentages by columns and the second by rows. (The zero-column and zero-row frequencies will be eliminated from the calculations of percentages)

21–22 Correlation-Coefficient Option—causes the computation of several correlation coefficients. The coefficients computed for each table depend on its numbers of rows and columns (excluding the zero categories):

Size of Table	*Correlation Coefficients*
n X n	Kendall tau-B, Goodman–Kruskal gamma, Somers D_{yx} and D_{xy}
n X m	Kendall tau-C, Goodman–Kruskal gamma, Somers D_{yx} and D_{xy}

Size of Table refers to the numbers of rows and columns after subtracting the zero categories, for the zero-row and zero-column frequencies will be excluded from the computation of these coefficients. (If the zero category for any variable is desired in the calculation, the variable can be recoded by adding 1 to every category (see below)

continued

23–24	Option for Treating Blanks as Missing Values—instructs the program to "throw out" blanks; they will not be counted or processed
25–26	blank
27–28	Nax-Value Option—allows elimination from the row-and-column percentage tables and statistical computations of the upper-limit categories of specified variables. [If exercised, Nax-Value Cards must be prepared (see Nax-Value Cards, below) and must follow the Max-Value Cards in the Control-Card deck]
29–30	EOFOK Option—allows the user to process data where the number of cases is not known, by instructing the program to read in data until it reaches an end of file. The program will process all cases read and will include in the output the number of cases processed. [If this option is *not* exercised (zero or blank in this field), the program will terminate with an error message if an end of file is encountered *before* the number of cases specified (in Cols. 1–4 of this card) are read]

Format Cards (Cards 5,6, and 7)

The Format Cards instruct the program as to which variables are to be read and where these are located on the data cards. Variables are numbered by the program in the order in which they are read. There must be one I specification per variable and the number of specifications must be equal to the number punched on Cols. 5,6 of the Main-Parameter Card. Each case *must be on a separate card.* Multiple-card cases can be processed.

Columns 1–80 of each card are available for punching the format. The statement must begin with a left parenthesis and end with a right one. The three cards constitute, effectively, one continuous 240-column alphanumeric field, so that, where the format extends beyond Col. 80 of card 5, it is simply continued onto card 6 and, if required, to card 7. Cards 6 and 7 *must* be included in the Control-Card deck *even if they are blank. All data are to be read with I format.*

Maximum-Value Cards (Cards 8 and 8a)

Max-Value Cards state the highest value of a variable (after recoding, if any). The number of categories in the rows or columns of a table using that variable will be determined by the value entered in the corresponding field of Control Cards 8 and 8a. Max-Value can, however, be used to eliminate categories at the upper end of

continued

the range. To do this, the Max-Value for the given variable should be set equal to the highest value desired.

The minimum value for all variables is automatically set at zero. Negative values are treated as out of bounds and are not counted. Thus, if a user had negative values in his data and he wanted these categories to be processed, he would have to recode the variable in question. Conversely, if a user had several lower categories that he desired to eliminate, he should recode so as to set these values negative.

Card 8 has 40 control fields (one field for each variable) of two columns each. The Max-Value of variable 1 is punched in Cols. 1,2, that of variable 2 in Cols 3,4, etc. Card 8a has 40 control fields for the 41st–80th variables. If 50 variables are to be read, the first 40 maximum values are punched on card 8 and the values of the 41st–50th variables would be punched in Cols. 1–20 of Card 8a. Note that *card 8a is to be used only if more than 40 variables are being read.*

Nax-Value Cards (Cards 8b and 8c)

The Nax-Value Cards have 40 two-column fields, one field per variable. The numbers punched in these fields determine the value ranges that will be used in the generation of percentage tables and statistical computations, if the Nax-Value Option (Cols. 27, 28 of the Main-Parameter Card) has been exercised. In this case, Percentage-Table, Chi-Square, and Correlation-Coefficient Options also would have been specified on the Main-Parameter Card.

The user must specify a value on these cards for *each* variable being read, whether or not it is a variable whose upper limit is being altered for percentage computations. If five variables were being read, each with a value range of 1–4, and if it was desired to eliminate category 4 of variable 2, the Nax-Value Card would be punched 0403040404. The Max-Value Card, determining the categories used for table construction, would be punched 0404040404.

Again, if only 40 variables are being read, then only one Nax-Value Card need be prepared. The Nax-Value of a variable must be less than or equal to the Max-Value. If the Nax-Value is inadvertently punched as a value greater than the Max-, the program will terminate with an error message.

continued

Table-Selection Cards (Cards 9–12)

Cards 9a and 9b	First-dimension (column) variable
Cards 10a and 10b	Second-dimension (row) variable
Cards 11a and 11b	Third-dimension variable
Cards 12a and 12b	Fourth-dimension variable

The Table-Selection Cards are used to instruct the program as to which variables are to be used in constructing each table. The user identifies these variables by the order in which they were read (as specified on the Format Cards).

Each card consists of 40 two-column fields, one field per table. A maximum of 40 tables can be specified with the use of the "a" cards. If more than 40 tables are desired, the specifications are continued on the "b" cards. Where no more than 40 tables have been called for, the "b" cards should not be included in the Control-Card deck.

The first field for each of cards 9a, 10a, 11a, and 12a corresponds to the first table that the computer will construct. (If the user wishes to crosstabulate variable 26 by variable 13 in table 1, he punches 26 in Cols. 1,2 of card 9a and 13 in Cols. 1,2 of card 10a. Variable 26 will then appear along the columns of the first contingency table and variable 13 in the rows.) If only a bivariate distribution is desired, the corresponding fields in cards 11a and 12a should be left blank. If, however, the user wants to crossclarify the same pair of variables while holding a third variable constant, he should punch the number of the third variable into Cols. 1,2 of card 11a. A fourth variable can be introduced in the table the same way with the use of card 12a.

When a third variable is used in a table, a separate subtable is prepared for each category of the third variable. The computer screens the data, selects all observations falling into the first category of the third variable, and prepares from this subset of the data a crossclassification of the first and second variables selected. It then follows the same procedure for the second category of the third variable, etc. (If *sex*, with a value range of 1–3, had been selected as a third-dimension variable, three separate crossclassification tables would be generated: for individuals of sex 1 by variable x by variable y, of sex 2 by x by y, and of sex 3 by x by y. If the set of data being processed did not include any individuals of sex 3, the subtable would be all zeros and would not be generated.)

continued

There is no limitation on the number of categories for third- or fourth-dimension variables, but, since a subtable is prepared for each value (except zero) of a third-dimension variable, a user would generally wish to avoid selecting one with a large number of categories. When a fourth-dimension variable is used, a subtable is generated for each combination of values of the third- and fourth-dimension variables (except zero); i.e., the number of subtables generated is equal to the number of categories (Max-Value) for the third variable multiplied by the number of categories for the fourth. A given variable may be selected for as many tables as desired, or for none at all.

The largest table that the program can handle is 20X99; 21 columns, including zero, is the maximum table width. Similarly, 100 rows, including zero row, is the maximum table length. Therefore, *Max-Value of a first-dimension variable should never be more than 20.* A variable with more than 20 categories can be used as a first-dimension variable by setting the Max-Value at 20, thereby eliminating categories beyond this limit. If this is not appropriate to the research, existing value ranges can be altered by means of recoding (see Recode Control Cards). Note again that the Max-Value of a variable means the highest value to be processed after recoding, if any. Therefore, selecting variables, setting Max-Values, etc., should always be based on the Post-Recode value range rather than on the original value range.

Table-Selection Cards should be prepared as follows.

Card 9a. Forty control fields (one per table) of two columns each. The number of the variable that a user has selected as his first-dimension variable for table 1 should be punched in Cols. 1,2, the first-dimension variable of table 2 should be designated in Cols. 3,4, etc.

Card 9b. If more than 40 tables have been called for, then an additional 32 control fields (two columns each) are available on card 9b, to provide a maximum of 72 fields. Card 9b, if used, should be placed immediately behind card 9a. Where no more than 40 tables have been called for, card 9b should not be included.

Card(s) 10a, b. Forty control fields, one per table; information continued onto following card 10b *only if necessary* (same as above). Second-dimension variables are designated in this card or pair of cards.

Card(s) 11a, b. Same as cards 9 and 10, except that third-dimension variables are designated on card(s) 11. Where no third dimension is

continued

desired, the corresponding control field of card(s) 11 must be zero or blank. (Card 11a *must* be included even if all tables are two-dimensional and the card is entirely zero or blank. Similarly, card 11b must be included, whether blank or not, *but only if more than 40 tables are called for.*)

Card(s) 12a, b. Same as above, except that fourth-dimension variables are designated on card(s) 12.

Example. Five tables are desired, as follows.

	Table 1 Cols. 1,2	Table 2 Cols. 3,4	Table 3 Cols. 5,6	Table 4 Cols. 7,8	Table 5 Cols. 9,10
Card 9a 1st Dim.	17	12	8	4	4
Card 10a 2nd Dim.	2	14	6	12	14
Card 11a 3rd Dim.	5		2		
Card 12a 4th Dim.			5		

These Table-Selection Cards would indicate to the computer that variables 17, 2, and 5 are to be used in constructing the three-dimensional table 1, etc.

Recoding Option

The six types of recoding operations are—

Code	*Option*
01	Recode by adding some constant to the value
02	Recode by subtracting some constant from the value. (Where a negative value results, datum is treated as out of bounds)
03	Recode by dividing some constant to the value (no rounding; e.g., 89/30 = 2)
04	Recode by regrouping the data into specified intervals
05	Recode by regrouping the data into specified intervals *and* addition
06	Recode by regrouping the data into specified intervals *and* subtraction
07	Recode by regrouping the data into specified intervals *and* division

continued

If the Recode Option (card 4, Cols. 11–12) is "no," Recode-Control Cards should *not* be used. If the Recode Option is "yes," Recode Control Cards must be prepared as follows.

Note that, if more than 40 variables are being used, and *if* recoding has been called for, then a second Recode-Selection Card must be prepared, whether blank or not, and placed right after the first Recode-Selection Card; and a second Constant Card (blank or not) must be placed behind the first Constant Card.

Recode-Selection Card(s)

Eighty fields (one per variable), of two columns each. The first 40 fields for the first 40 variables are on Recode Card 1; the fields for variables 41–80 are on card 2.

The number of the recode type (shown above) to be used for a given variable should be punched in the corresponding control field. If a given variable is not recoded, the corresponding control field must be blank or zero.

Constant Card(s)

Eighty fields (one per variable) of two columns each. The first 40 fields for the first 40 variables are on Constant Card 1; the fields for variables 41–80 are on Constant Card 2.

The constants to be used for the addition, subtraction, or division recoding operations should be given in the corresponding fields of the Constant Card. If, for example, it is desired to recode variable 7 by subtracting a value of one from each category, the code number 02 should be punched in Cols. 13,14 of Recode Selection Card 1 and the constant 01 punched on Cols. 13,14 of Constant Card 1.

Where no recoding or recode type 04 was called for, the corresponding field on the Constant Card is irrelevant. The Constant Card(s) *must be included* if the Recode Option was specified on the Main-Parameter Card (even if type 04 is the only recode operation called for and thus the entire Constant Card(s) is irrelevant).

Regrouping Card(s)—[Upper-Limit Card(s)]

If coding by regrouping (types 04, 05, 06, or 07) is specified for one or more of the variables, then the user must prepare one Regroup Card (also called *Upper-Limit Card*) for each variable to be recoded in this manner. Regroup Cards used must be in order according to variable sequence. Where no variables are being regrouped, no Regroup Cards should be used.

continued

Each Regroup Card contains 16 five-column fields (from Cols. 1 through 80), providing a maximum of 16 categories into which each variable might be regrouped. Reading from left to right, the first 5-column field should contain the upper limit of the first interval into which the data are to be regrouped; the second 5-column field should contain the upper limit of the second interval; etc.

If recode types 05, 06, or 07 are requested, the regrouping will be done before addition, subtraction, or division. Assume, for example, that it is desired to recode raw age figures into these categories: under 21, 21–30, 31–40, 41–50, and 51 to age 100. The Regroup Card for this variable should contain the value 00020 in Cols. 1–5, 00030 in Cols. 6–10, 00040 in Cols. 11–15, 00050 in Cols. 16–20, and 00100 in Cols. 21–25. The Max-Value for this variable would be 4, since all data of the given variable with values less than or equal to the first upper limit (Cols. 1–5) are set to zero; data values larger than the first upper limit but less than or equal to the second (Cols. 6–10) are recoded as 1, etc. Successive intervals are defined by their upper limits and all values falling in the k^{th} interval are set equal to k – 1; they become the $(k - 1)^{th}$ category. See illustration below.

Original Data Values	0–20	21–30	31–40	41–50	51–100
Regroup Card	00020	00030	00040	00050	00100
Values after Regrouping (Max-Value)	0	1	2	3	4

Variable-Name Cards

A set of Variable-Name Cards must be used whenever the Variable-Name Option (card 4, Cols. 9–10) is specified and must *not* be used where it is not. The set must include one card for each variable read. The name or description of each variable should be punched in Cols. 1–72, one card per variable.

Limitations

Number of variables	≤80
Number of tables per problem	≤72
Number of problems per run	≤99
Number of cases	≤9999
Largest table	20X99

continued

There is no limitation on the number of categories for third- or fourth-dimension variables, but, since a subtable is prepared for each value (except zero) of a third-dimension variable, a user would generally wish to avoid selecting one with a large number of categories. When a fourth-dimension variable is used, a subtable is generated for each combination of values of the third- and fourth-dimension variables (except zero); i.e., the number of subtables generated is equal to the number of categories (Max-Value) for the third variable multiplied by the number of categories for the fourth.

Job Deck Structure

```
System Control Cards
Job Card
REQUEST(TAPE1,n,m)  HANG REEL XXXX
                    (where n = density
                    and m = X, if data       If data are on tape
                    tape has not been
                    written by the 6400)
LIBRARY(NUCROS)
LGO.
7-8-9  (End of Record)

(NUCROS Control Cards)
1              Problem Card (required)
2,3            Title Cards (required)
4              Main-Parameter Card (required)
5,6,7          Format Cards (required)
8,8a           Max-Value Card(s) (required)
8b,8c          Nax-Value Card(s) (optional)
9,10,11,12     Table-Selection Card(s)
               If more than 40 tables are
               specified, order of Table-
               Selection Cards must be 9a,
               9b,10a,10b,...,12b (required)    Repeat for as many
Recode-Selection Card (only if recoding          problems as necessary
               is called for)
Constant Cards (only if recoding is
               called for)
Regroup Cards (only if regrouping is
               called for)
Variable-Name Cards (only if Variable-
               Name Option is exercised)
Data cards, unless data input is on tape
6-7-8-9  (End of Information)
```

SAMPLE INPUT

```
VLORR.[redacted].CM72600.   NUCROS
LIBRARY(NUCROS)
LGO.
01
 NUCROS CROSS CLASSIFICATION PROGRAM  EVESAMPLE

 100 2 13344 0 0 1 1 1 0 0 0 0
(24X.2I1)


0306
01
02


0101
0101
NBR
VISIT
C24   9521 551102130   125                                               EVES
C24  103101242103112  5125                                               EVES
C24  24750 9 03030  0  124                                               EVES
C24  27750 9 03030 10 5124                                               EVES
C24  3639117531321 00 6404                                               EVES
C24  3763110523031 30  325                                               EVES
C24  4239112521031 11 8314                                               EVES
C24  4834114521020 2117515                                               EVES
C24  5533012 41000 22 8004                                               EVES
C24  6237112521121 11 7304                                               EVES
C24  6640110321121 54 5312                                               EVES
C24  6736112531131 6412214                                               EVES
C24  6826012 21031 00  324                                               EVES
C24  7241012441031 20 8211                                               EVES
               .                                                          .
               .                                                          .
               .                                                          .
C24 26043110231131 57 8124                                               EVES
C24 26237112341121 65  114                                               EVES
C24 265551 6321030 10  113                                               EVES
C24 267391 9321131 51 6114                                               EVES
C24 27142116521121 00 4002                                               EVES
C24 27227115541201 7011514                                               EVES
C24 27333015531121 50 6014                                               EVES
C24 27963116 41031 50 9314                                               EVES
C24 28138016 41031 4315500                                               EVES
C24 28836010 11001 1412310                                               EVES
C24 29153012 41131 30 8004                                               EVES
C24 29232114531000 10 4214                                               EVES
C24 293581 8521021 40 5115                                               EVES
C24 29451117541021 5112313                                               EVES
```

SAMPLE OUTPUT

```
 NUCROS CROSS CLASSIFICATION PROGRAM  EVESAMPLE

TOTAL CASES EXPECTED= 100       PROBLEM NO.  1 OF   1
 FORMAT IS (24X,2I1)


VARIABLE    1  2
MAX.VALUE   3  6

         TABLE NO.       VARIABLES        MAXIMUM VALUES
              1           1  2              3   6




RECODING OPTION CALLED FOR
VAR.
NO.CODE CONST. RECODED CATEGORIES (UPPER LIMITS)

 1   1    1
 2   1    1



VAR.NO.

   1  NBR
   2  VISIT
```

continued

```
 TABLE NO.    1             VARIABLE NO.  1  NBR
 -------------        VRS.  VARIABLE NO.  2  VISIT
TABLE SIZE =    4   BY   7

          TOT        0    1    2    3

    0       0        0    0    0    0
    1       7        0    3    4    0
    2       9        0    3    6    0
    3       9        0    1    6    2
    4       9        0    1    5    3
    5      41        0    6   19   16
    6      25        0    0   14   11

  TOTAL   100        0   14   54   32

X2=  18.352  C=  .394  T-C=   .300  G=   .457  SE-G=   .096  Z-G= -4.738  L-A=  0.000  L-B=  0.000  L=  0.000  DXY=   .270  DYX=   .341

 PERCENTS BY COLUMN FROM THE ABOVE MATRIX

    1     7.0           21.4  7.4  0.0
    2     9.0           21.4 11.1  0.0
    3     9.0            7.1 11.1  6.3
    4     9.0            7.1  9.3  9.4
    5    41.0           42.9 35.2 50.0
    6    25.0            0.0 25.9 34.4

  TOTAL   100            14   54   32


 PERCENTS BY ROW FROM THE ABOVE MATRIX

    1       7           42.9 57.1  0.0
    2       9           33.3 66.7  0.0
    3       9           11.1 66.7 22.2
    4       9           11.1 55.6 33.3
    5      41           14.6 46.3 39.0
    6      25            0.0 56.0 44.0

  TOTAL   100           14.0 54.0 32.0



1 PROBLEM(S) COMPLETED - THIS JOB DONE
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 0.953 seconds for central-processor time and 19.596 seconds for peripheral-processor time with a memory useage of 72,600 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—NUCROS

pages

1 Identification & Abstract
3–12 User Instructions
13–15 I/O
17 Cost—Contents

DESCRIPTIVE TITLE	Critical-Path Summary—Probability Statistic Based on Normal Curve
CALLING NAME	PERTC NUCC022
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center Northwestern University
LANGUAGE	CDC FORTRAN
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

PERTC produces a detailed scheduling network, final critical-path summary, and probability statistic for events that are normally distributed about some mean.

REFERENCES

Rogers, H.B., "Construction Project Pert Network," Northwestern Univ. Grad. School Business (Jan. 1964; unpublished). A reference copy may be obtained from the EIN office for the cost of duplicating and mailing.

USER INSTRUCTIONS

Description of Input Data

Problem Setup Card

Columns	*Contents*
1– 3	Number of activities—i.e., the number of occurrences that happen between two arbitrarily established points in time that the network plan uses for estimation
4– 6	First activity number to begin the network—i.e., the starting point
7– 9	Last activity number to end the network
10–14	Completion time desired; if none specified, mean is assumed and the probability statistic will be .5

Activity-Card Setup

There will be a number of Activity Cards less than or equal to 999 and equal to the number punched into Cols. 1–3 on the Problem Card.

Note: Maximum number-value assignment with which one may identify an activity is 999. This is a function of the program and in no way is necessarily binding if one should care to change certain elements in the source program.

Columns	*Contents*
1– 6	Any alphanumeric information; if punched, it must be punched on all Activity Cards. It is a job-batch check
7– 9	Predecessor-event number
10–12	Successor-event number
13–17	Optimistic time estimate (F5.0)
18–22	Most-likely time estimate (F5.0)
23–27	Pessimistic time estimate (F5.0)

A blank card must follow the set of Activity Cards.

Jobs may be stacked one on top of the other. *The last card in each group of jobs must be blank.*

continued

Description of Output

Primary Output—consists of complete activity table consisting of

(1) Predecessor-event number
(2) Successor-event number
(3) Optimistic time estimate (OTE)
(4) Most-likely time estimate (MLTE)
(5) Pessimistic time estimate (PTE)
(6) Weighted time: [OTE + 4(MLTE) + PTE]/6
(7) Earliest time that an event can be expected to be completed
(8) Latest time for the predecessor event for the given activity
(9) Latest time for the successor event for the given activity
(10) Slack time allowable along this activity's path

Secondary Output—consists of a table showing pert calculations and critical-path summary. In the case of a parallel path, the computer takes one of the paths only. If it is seen that a path was chosen that does not have the highest variance, merely pull the cards that were chosen and resubmit. The probability statistic will then be corrected.

The output in this table consists of the activity identification, the optimistic and pessimistic times, the earliest time that an event could be completed following achievement of the predecessor event, the calculation of the range (OTE-PTE), the range/6, and the variance $[(\text{range}/6)^2]$. These things come out for each activity on the critical path. The ratio of the standard deviation to the mean is calculated, and then a probability statistic is printed.

Error Indications (See also Additional Information, below)

The program will print out error messages in the event of unspecified completion times or errors in the Start Card.

Limitations (See also Additional Information, below)

Maximum 999 Activity Cards allowed; not more than 50 dependent decision links. All events must eventually terminate by linking up to the last even that you designated in the card that sets up the problem.

Additional Information

General Program Precautions

No event may appear in the predecessor-event column unless it is listed previously in the successor-event column of a preceding Activity Card. *Exception:* the first event in the network. If this specification is violated, the following will print out:

continued

LOOKING FOR PRECEDING EVENT NUMBER FOR ACTIVITY CARD NUMBER ____ and your output will be valueless. The number that prints out is the total number of cards to remove from the data deck. The following card will be the incorrectly punched or linked card. The offending number will be punched in Cols. 7–9. Activity-number assignments are arbitrary. You may use a number only once, but it makes no difference if you begin high, low, or intermediate in the number series. If you follow the precaution above, you will be correct.

The program assumes that there will not be more than 50 dependent decision links in a network of 1000 or less events. If this is found to be incorrect, the necessary change may be made on the FORTRAN statement following statement 5 in the source program (DO 503 M = 1,50).

Job Deck Structure

```
Job Card
LIBRARY (PERTC)
LGO.
7-8-9 EOR
                Problem Card   ─┐ repeat
                Activity Cards  │ for each
                Blank card     ─┘ job
6-7-8-9 EOI
```

SAMPLE INPUT

```
VLORH,[redacted],CM57300.    PERTC
LIBRARY(PERTC)
LGO.
147100999
        100101  1.5   2.0   3.5
        100110  3.0   4.0   5.0
        100201  5.0   6.0   6.0
        100801  1.0   2.0   2.0
        100803  3.0   4.0   6.0
        101102  1.4   2.0   3.0
        101103  2.0   6.0   7.0
        101106  2.6   3.0   6.0
        102103  0.0   0.0   0.0
        103105  1.4   2.0   3.0
        103300  3.0   4.0   5.0

          .      .     .
          .      .     .
          .      .     .
        770990  1.0   2.0   2.5
        715725 12.0  14.0  18.0
        725750  3.0   4.0   5.0
        801803  1.0   1.0   1.5
        801715  0.0   0.0   0.0
        801716  0.0   0.0   0.0
        716726 12.0  14.0  18.0
        726760  3.0   4.0   5.0
        803805  0.6   1.0   1.2
        805315  0.0   0.0   0.0
        805415  0.0   0.0   0.0
        805515  0.0   0.0   0.0
        805990  2.0   3.0   5.0
        805615  0.0   0.0   0.0
        900905  0.8   1.0   1.2
        905930  2.0   3.0   4.0
        905955  7.0   8.0  12.0
        930955  0.0   0.0   0.0
        955770  0.0   0.0   0.0
        955965  2.0   2.0   4.0
        965370  0.0   0.0   0.0
        965380  0.0   0.0   0.0
        965570  0.0   0.0   0.0
        965580  0.0   0.0   0.0
        965780  0.0   0.0   0.0
        965672  0.0   0.0   0.0
        990995  2.0   2.0   3.0
        995999  1.0   1.0   1.0
```

SAMPLE OUTPUT

```
PRED.  SUCC.     T OP.   T ML.   T PE.   SUCC.   SUCC.   PRED.   SUCC.   SLACK
EVENT  EVENT                             TE      TE      TL      TL

100    101        1.50    2.00    3.50    2.17    2.17    -.00    2.17    -.00
100    110        3.00    4.00    5.00    4.00    4.00    6.67   10.67    6.67
100    201        5.00    6.00    6.00    5.83    5.83   28.82   34.65   28.82
100    801        1.00    2.00    2.00    1.83    1.83   10.85   12.68   10.85
100    803        3.00    4.00    6.00    4.17    4.17    9.60   13.77    9.60
101    102        1.40    2.00    3.00    2.07    4.23    5.60    7.67    3.43
101    103        2.00    6.00    7.00    5.50    7.67    2.17    7.67    -.00
101    106        2.60    3.00    6.00    3.43    5.60   12.73   16.17   10.57
102    103        0.00    0.00    0.00    0.00    4.23    7.67    7.67    3.43
103    105        1.40    2.00    3.00    2.07    9.73   11.60   13.67    3.93
103    300        3.00    4.00    5.00    4.00   11.67   19.40   23.40   11.73
                    .       .       .
                    .       .       .
                    .       .       .
750    770        1.00    2.00    4.00    2.17   20.00   53.15   55.32   26.32
770    990        1.00    2.00    2.50    1.92   30.92   55.32   57.23   26.32
715    725       12.00   14.00   18.00   14.33   22.63   34.82   49.15   26.52
725    750        3.00    4.00    5.00    4.00   26.63   49.15   53.15   26.52
801    803        1.00    1.00    1.50    1.08    2.92   12.69   13.77   10.85
801    715        0.00    0.00    0.00    0.00    1.83   34.82   34.82   32.98
801    716        0.00    0.00    0.00    0.00    1.83   33.57   33.57   31.73
716    726       12.00   14.00   18.00   14.33   16.17   33.57   47.90   31.73
726    760        3.00    4.00    5.00    4.00   20.17   47.90   51.90   31.73
803    805         .60    1.00    1.20     .97    5.13   13.77   14.73    9.60
805    315        0.00    0.00    0.00    0.00    5.13   30.40   30.40   25.27
```

continued

000 0029

805	415	0.00	0.00	0.00	0.00	5.13	33.23	33.23	28.10
805	515	0.00	0.00	0.00	0.00	5.13	14.73	14.73	9.60
805	990	2.00	3.00	5.00	3.17	8.30	54.07	57.23	48.93
805	615	0.00	0.00	0.00	0.00	5.13	32.40	32.40	27.27
900	905	.80	1.00	1.20	1.00	16.73	29.23	30.23	13.50
905	930	2.00	3.00	4.00	3.00	19.73	35.73	38.73	19.00
905	955	7.00	8.00	12.00	8.50	25.23	30.23	38.73	13.50
930	955	0.00	0.00	0.00	0.00	19.73	38.73	38.73	19.00
955	770	0.00	0.00	0.00	0.00	25.23	55.32	55.32	30.08
955	965	2.00	2.00	4.00	2.33	27.57	38.73	41.07	13.50
965	370	0.00	0.00	0.00	0.00	27.57	53.07	53.07	25.50
965	380	0.00	0.00	0.00	0.00	27.57	53.07	53.07	25.50
965	570	0.00	0.00	0.00	0.00	27.57	41.07	41.07	13.50
965	580	0.00	0.00	0.00	0.00	27.57	41.07	41.07	13.50
965	780	0.00	0.00	0.00	0.00	27.57	54.23	54.23	26.67
965	672	0.00	0.00	0.00	0.00	27.57	52.23	52.23	24.67
990	995	2.00	2.00	3.00	2.17	50.40	57.23	57.40	0.00
995	999	1.00	1.00	1.00	1.00	60.40	59.40	61.40	0.00
		⋮	⋮	⋮					

continued

```
PERT CALCULATIONS FOLLOW

 ACTIVITY            T OP          T PE            T E          RANGE      RANGE/6     RANGE/6 SQ |
100 - 101            1.50          3.50            2.17          2.00        .33              .11
                                           ------------                           ------------
                                                   2.17                                       .11
                                           ------------                           ------------
                                                   2.17                                       .11
                                           ------------                           ------------
                                                   2.17                                       .11
                                           ------------                           ------------
                                                   2.17                                       .11
                                           ------------                           ------------
                                                   2.17                                       .11
                                           ------------                           ------------
                                                   2.17                                       .11
101 - 103            2.00          7.00            5.50          5.00        .83              .69
                                           ------------                           ------------
                                                   7.67                                       .81
                                           ------------                           ------------
                                                   7.67                                       .81
                                           ------------                           ------------
                                                   7.67                                       .81
                                           ------------                           ------------
                                                   7.67                                       .81
                                           ------------                           ------------
                                                   7.67                                       .81
                                           ------------                           ------------
                                                   7.67                                       .81
103 - 500            4.00          8.00            6.00          4.00        .67              .44
                                           ------------                           ------------
                                                  13.67                                      1.24
                                           ------------
                                             .     .     .
                                             .     .     .
                                             .     .     .
```

continued

```
                                                 ------------                                   ------------ •
                                                        57.23                                           4.05
990 - 995          2.00          3.00                   2.17          1.00          .17                  .33
                                                 ------------                                   ------------
                                                        59.40                                           4.38
995 - 999          1.00          1.00                   1.00          0.00          0.00                0.00
                                                 ------------                                   ------------
                                                        60.40                                           4.38


NO COMPLETION TIME SPECIFIED---ASSUMING     60.40 TIME UNITS. PROCESSING CONTINUES .
RATIO OF ST. DEV. /MEAN TIME.   .035
ST. DEV.     2.09


THERE IS A .50 PROBABILITY OF COMPLETION IN      60.40 TIME UNITS .


THIS SEQUENCE OF JOBS HAS TERMINATED
```

continued

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 60.323 seconds for the central-processor time and 14.756 seconds for peripheral-processor time with a memory useage of 57,300 words. Chargeable computer time was $8.98.

Charge to user = computer time + postage and handling + network overhead
= $8.98 + $15.00 + network overhead
= $23.98 + network overhead

CONTENTS—PERTC

pages

1 Identification & Abstract
3–5 User Instructions
7–11 I/O
13 Cost—Contents

DESCRIPTIVE TITLE	Punch and Print Rankings
CALLING NAME	PPRANK NUCC023
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

PPRANK is able to rank raw data for as many as 100 subjects on as many as 140 variables and to punch out these ranks. A nonparametric Spearman product-moment correlation is performed upon the ranks, with respect to the raw data. Consensus ratings may be produced and tested for significance by using the Kendall W coefficient of concordance. No missing-data option is available.

The subjects are ranked with respect to each variable. The rank 1 is assigned to the subject with the smallest (i.e., most negative) sample value of the variable being considered. Subjects that tie at a sample value are assigned a rank that is the average of the tied ranks. A consensus ranking of the subject can be selected by specifying as many as 20 variables as the ones whose ranks are to be summed and ranked. The consensus ranking itself then becomes an additional variable. Ties among the sums of ranks are resolved by comparison of the sums of squares of ranks; the smaller the sum of squares of ranks, the lower the rank assigned the sum of ranks. Should ties still persist, an average rank is assigned. It is not statistically sound to form consensus ranks from variables that are not in accord (as measured by a W test at the significance level set by the user).

USER INSTRUCTIONS

Description of Input

The five types of cards used for input to PPRANK are the Problem Card, the Format Card(s), the Subject-Name Card(s), the Consensus-Variable Card(s), and the Finish Card. Variable format is used in the reading of input data.

Problem Card

Columns	*Parameter*	*Contents*
1– 6		*SETUP
7– 9	ISUB	Number of subjects ($\leq$100)
10–12	IVAR	Number of variables before any consensus variables are formed (orig. + consensus $\leq$140)
13	IARR	Value of IARR (see below)
14	INAME	= 1 if Subject-Name Card(s) are to be used (see below) ≠ 1 otherwise
15	IFORMT	Number of Variable-Format Cards ($\leq$9)

The parameter IARR controls the reading of data, according to the following coding.

IARR = 1	ISUB sets of data cards are read in; a set may consist of one or more cards. The first value read off each set is an identification (IDENT) for that set ($\leq$A6). The IDENT is followed by the IVAR sample values of the variables on the subject represented by this set
IARR = 2	Same as above, except that IDENT is read *after* the IVAR sample values
IARR = 3	IVAR sets of cards are read in, one for each variable. Each set contains the ISUB sample values of one variable on all ISUB subjects. No IDENT is read for the subjects; it is assumed that IDENT is blank for every subject

Subjects are assigned names in one of three ways:

(1) The IDENT for each subject can be read off each data set— IARR = 1 or 2). This IDENT could be all blanks, especially if IARR = 2

continued

(2) The IDENT is assumed to be blank if IARR = 3

(3) Subjects may be named on Subject-Name (*SNAME) Cards. Any IDENT read under (1) or assumed under (2) above is superseded by a name specified on an *SNAME card

The formation of consensus variables is controlled by *ADVAR cards. The formation of a consensus variable increases the number of variables by one. *Restriction:* The sum of original variables and consensus variables must be ≤140.

Format Card(s)

Columns	*Contents*
1– 6	*FORMT
7–72	Format (in F or E notation)

Examples for ISUB = 30, IVAR = 21, for which each set will contain three cards:

if IARR = 1, then IDENT is read first, followed by 21 sample values
*FORMT(A6,7F10.0/(6X,7F10.0)) or
*FORMT(A6,7F10.0/2(6X,7F10.0))

if IARR = 2, then IDENT is read after the 21 values
*FORMT(2(8F10.0/),5F10.0,A1)

if IARR = 3, then 30 sample values are read in with no IDENT
*FORMT(10F8.0) or
*FORMT(3(10F8.0/))

Subject-Name Card(s)

Columns	*Card*	*Contents*
1– 6	1	*SNAME
7–12		IDENT for 1st subject
13–18		IDENT for 2nd subject
⋮		⋮
61–66		IDENT for 10th subject
1– 6	2	*SNAME
7–12		IDENT for 11th subject
⋮		⋮
61–66		IDENT for 20th subject
⋮	⋮	⋮

continued

Include only as many *SNAME cards as are needed. For example, if ISUB = 41, five *SNAME cards would be required.

Consensus-Variable Card(s)

The presence of the Consensus-Variable Card causes the number of variables (IVAR) to be increased by one.

Type One

Columns	*Parameter*	*Contents*
1– 7		*ADVAR1
8–10	NADD	Number of variables used to form this consensus variable (≤20)
11–13	IADD(1)	Number of first variable to be used
14–16	IADD(2)	Number of second variable to be used
⋮	⋮	⋮
.	IADD(NADD)	Number of last variable to be used

Each IADD value must be less than or equal to the present value of IVAR (i.e., ≥1 and ≤139).

Type Two

Columns	*Parameter*	*Contents*
1– 7		*ADVAR2
8–10	ISTART	Number of first variable to be used (≥1)
11–13	ISTEP	Increment by which to increase the number of variable to be used (≥0)
14–16	ISTOP	Number of last variable to be used (≤139 and ≤IVAR but ≥ISTART)

Note: As many as 139 variables can be used to form a consensus variable by using an *ADVAR2 card.

Finish Card

Columns	*Contents*
1– 6	*FINIS

Note: No punched output can be obtained until after a *FINIS card has been read.

continued

Description of Output

The output consists of a set of cards for each subject. Each card in a set contains as many as 14 ranks. The number of cards in a set is determined by the total number of variables. (For example, 30 would be punched as the second rank on the third card of each set.) The format is (I3,I1,A6,14F5.1) for each card in the set.

Columns	*Contents*
1– 3	Number of the subject (≤100)
4	Position of this card in its set—i.e., 0 is the first card, 9 is the tenth.
5–10	Identification for the subject (IDENT)
11–80	Ranks

The printout consists of the original variables listed with the rank for each subject. Following this are the consensus variables and the ranks of the subjects on the sum of the ranks. For each consensus variable, the Kendall W coefficient is calculated and the chi square is calculated with the proper degrees of freedom for testing the significance of the consensus variable. Finally, a matrix is labelled as card output is printed, containing the same information as the punched cards.

Limitations

Number of original and number of consensus variables	≤140
Number of subjects	≤100
Number of Variable-Format Cards	≤9
Number of variables in consensus	≤20

Job Deck Structure

Job Card
LIBRARY(PPRANK)
LGO.
7–8–9 (EOR Card)
Problem Card
Format Card(s)
Data Cards
Subject-Name Card(s), if used
Consensus-Variable Card(s), if used
Finish Card
6–7–8–9 (EOI Card)

Repeat if multiple run is desired

SAMPLE INPUT

```
VLORR,CH[redacted],CM51600.    PPRANK
LIBRARY(PPRANK)
!.GO.
*SETUP017011301
*FORMT(8X,17(F1.0,2X))
01084450322236429533418511234444333433749513630328417142633                2.529
01009450420325143737334433425620238249620526531421438333527                2.647
01079450424323238539437436327534239435621729534430135331627                2.647
010814504323381475214265293356394374335316 2326231437231728                2.75
01080450625338645543327248338530425249530411739144423422424                2.824
01046450540335411540530333242742321421625424433238430148643                3.000
01001450439339333737436432234439337530538538636639235132433                3.000
01023450434234341540339436422632141243744623431524338437521                3.059
01008450520423146637244424440545245344645745435340344433531                3.412
01082450449349347445445613240548147340749644442435531242545                3.706
01041450746140443545440443242544240344543446342642643345440                4.000
*ADVAR2001001003
*ADVAR2001001004
*ADVAR2001001005
*ADVAR2001001006
*ADVAR2001001007
*ADVAR2001001008
*ADVAR2001001009
*ADVAR2001001010
*ADVAR2001001011
*FINIS
      .          .             .          .                                .    13 additional runs
      .          .             .          .                                .    included here
      .          .             .          .                                .
*SETUP017012301
*FORMT(8X,17(F1.0,2X))
01041443648242224114544644974464154934554944634844654744034 4              4.000
01001443638639233732235438534537435535432335437331434139335                3.000
01046443435532327424238413538138640430327520249412745642333                2.765
01023443335522627333246417136428646242536433323433747539414                2.765
01008443734640641413141438323310548444422219538234431538317                2.706
01079443339722532324336422437221532436530427420136635635228                2.588
01081443533643428714235423532230424333423111320420531640338                2.529
01084443528640640326233326530410746221327423146423417527415                2.412
01082443641714224428326313438410543340527515422415635245141                2.412
010834433263214 45385281 92377 46323394245266344174262314 25               2.35
01080443524635423634234416317523743428314425313134224536417                2.118
01009443516629334513238422419136736341417417227413538620319                2.000
*ADVAR2001001003
*ADVAR2001001004
*ADVAR2001001005
*ADVAR2001001006
*ADVAR2001001007
*ADVAR2001001008
*ADVAR2001001009
*ADVAR2001001010
*ADVAR2001001011
*ADVAR2001001012
*FINIS
      .          .             .          .                                .    7 additional runs
      .          .             .          .                                .    included here
      .          .             .          .                                .

      .          .             .          .                                .
```

SAMPLE OUTPUT

```
PPRANK PROGRAM


VARIABLE NUMBER   1

SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK

  1  30.000000E-01    5.0           2  20.000000E-01    2.5           3  40.000000E-01    9.0           4  50.000000E-01   13.0
  5  40.000000E-01    9.0           6  50.000000E-01   13.0           7  20.000000E-01    2.5           8  40.000000E-01    9.0
  9  30.000000E-01    5.0          10  40.000000E-01    9.0          11  70.000000E-01   17.0          12  50.000000E-01   13.0
 13  60.000000E-01   15.5          14  30.000000E-01    5.0          15  40.000000E-01    9.0          16  10.000000E-01    1.0
 17  60.000000E-01   15.5

VARIABLE NUMBER   2

SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK

  1  40.000000E-01    9.0           2  30.000000E-01    5.0           3  10.000000E-01    1.0           4  70.000000E-01   17.0
  5  30.000000E-01    5.0           6  40.000000E-01    9.0           7  40.000000E-01    9.0           8  60.000000E-01   15.5
  9  20.000000E-01    2.5          10  20.000000E-01    2.5          11  60.000000E-01   15.5          12  50.000000E-01   13.0
 13  50.000000E-01   13.0          14  40.000000E-01    9.0          15  40.000000E-01    9.0          16  30.000000E-01    5.0
 17  50.000000E-01   13.0
         .                                 .                                 .                                 .
         .                                 .                                 .                                 .
         .                                 .                                 .                                 .
VARIABLE NUMBER  11

SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK        SUBJ      DATA        RANK

  1  70.000000E-01   17.0           2  10.000000E-01    1.0           3  40.000000E-01    9.0           4  50.000000E-01   13.0
  5  40.000000E-01    9.0           6  40.000000E-01    9.0           7  20.000000E-01    2.5           8  50.000000E-01   13.0
  9  20.000000E-01    2.5          10  30.000000E-01    5.0          11  50.000000E-01   13.0          12  40.000000E-01    9.0
 13  30.000000E-01    5.0          14  60.000000E-01   15.5          15  60.000000E-01   15.5          16  30.000000E-01    5.0
 17  40.000000E-01    9.0

VARIABLE NUMBER  12 IS THE CONSENSUS OF   3 VARIABLES.
  1   2   3

KENDALL W COEFICIENT=  .79403

TEST FOR SIGNIFICANCE---CHISQ=   38.1137 WITH 16 DEGREES OF FREEDOM.

SUBJ      SUMR        RANK        SUBJ      SUMR        RANK        SUBJ      SUMR        RANK        SUBJ      SUMR        RANK

  1  23.000000E+00    9.0           2  12.500000E+00    3.0           3  12.500000E+00    4.0           4  43.000000E+00   14.5
  5  23.000000E+00    9.0           6  31.000000E+00   11.0           7  16.500000E+00    5.0           8  37.500000E+00   12.0
  9  10.000000E+00    1.0          10  20.500000E+00    7.0          11  48.000000E+00   17.0          12  43.000000E+00   14.5
 13  41.500000E+00   13.0          14  23.000000E+00    9.0          15  19.000000E+00    6.0          16  11.000000E+00    2.0
 17  44.000000E+00   16.0
         .                                 .                                 .                                 .
         .                                 .                                 .                                 .
         .                                 .                                 .                                 .
VARIABLE NUMBER  20 IS THE CONSENSUS OF  11 VARIABLES.
  1   2   3   4   5   6   7   8   9  10  11

KENDALL W COEFICIENT=  .55431

TEST FOR SIGNIFICANCE---CHISQ=   97.5582 WITH 16 DEGREES OF FREEDOM.

SUBJ      SUMR        RANK        SUBJ      SUMR        RANK        SUBJ      SUMR        RANK        SUBJ      SUMR        RANK

  1  11.750000E+01   11.0           2  50.000000E+00    2.0           3  63.000000E+00    5.0           4  14.950000E+01   16.0
  5  84.500000E+00    7.0           6  10.300000E+01   10.0           7  54.500000E+00    4.0           8  14.650000E+01   14.0
  9  45.000000E+00    1.0          10  71.500000E+00    6.0          11  16.500000E+01   17.0          12  14.650000E+01   15.0
 13  12.000000E+01   12.0          14  87.000000E+00    9.0          15  87.000000E+00    8.0          16  50.000000E+00    3.0
 17  14.250000E+01   13.0
```

continued

CARD OUTPUT

```
 10         5.0  9.0  9.0  9.0 15.5 13.0  9.0  9.0 13.0  9.0 17.0  9.0  9.5 11.0
 11        11.0 11.0 11.0 11.0 11.0 11.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 20         2.5  5.0  5.0  5.0  5.0  5.0  5.0  2.5  9.0  5.0  1.0  3.0  3.0  1.0
 21         2.0  3.0  2.0  3.0  3.0  2.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 30         9.0  1.0  2.5  1.0 15.5  9.0  5.0  5.0  1.0  5.0  9.0  4.0  2.0  6.0
 31         6.0  5.0  5.0  4.0  5.0  5.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 40        13.0 17.0 13.0 13.0 13.0 13.0 17.0 13.0 15.5  9.0 13.0 14.5 14.0 15.0
 41        14.0 16.0 16.0 16.0 15.0 16.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 50         9.0  5.0  9.0  9.0  5.0 13.0  9.0  5.0  2.5  9.0  9.0  9.0  9.5  8.0
 51         9.0  9.0  9.0  9.0  9.0  7.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 60        13.0  9.0  9.0 13.0  2.5  5.0  9.0  9.0  9.0 15.5  9.0 11.0 11.0 10.0
 61        10.0 10.0 10.0 10.0 10.0 10.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 70         2.5  9.0  5.0  5.0  5.0  2.5  2.5  9.0  9.0  2.5  2.5  5.0  5.0  3.0
 71         3.0  2.0  4.0  5.0  4.0  4.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 80         9.0 15.5 13.0 15.5 13.0 17.0  9.0 15.5 13.0 13.0 13.0 12.0 13.0 13.0
 81        15.0 14.0 14.5 13.5 13.5 14.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
 90         5.0  2.5  2.5  9.0  9.0  5.0  5.0  1.0  2.5  1.0  2.5  1.0  4.0  5.0
 91         5.0  4.0  3.0  1.0  1.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
100         9.0  2.5  9.0  9.0  2.5  9.0 13.0  2.5  5.0  5.0  5.0  7.0  8.0  7.0
101         7.0  8.0  7.0  7.0  6.0  6.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
110        17.0 15.5 15.5 13.0 13.0 15.5 13.0 17.0 15.5 17.0 13.0 17.0 16.5 17.0
111        17.0 17.0 17.0 17.0 17.0 17.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
120        13.0 13.0 17.0 15.5  9.0  9.0 13.0 15.5 17.0 15.5  9.0 14.5 15.0 14.0
121        13.0 13.0 13.0 15.0 16.0 15.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
130        15.5 13.0 13.0  5.0 17.0  9.0 15.5  9.0  9.0  9.0  5.0 13.0 12.0 12.0
131        12.0 12.0 12.0 12.0 12.0 12.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
140         5.0  9.0  9.0  2.5  1.0  2.5 15.5 13.0  5.0  9.0 15.5  9.0  6.0  4.0
141         4.0  6.0  8.0  8.0  8.0  9.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
150         9.0  9.0  1.0  9.0  9.0  9.0  2.5  5.0  5.0 13.0 15.5  6.0  7.0  9.0
151         8.0  7.0  6.0  6.0  7.0  8.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
160         1.0  5.0  5.0  2.5  9.0  1.0  1.0  9.0  9.0  2.5  5.0  2.0  1.0  2.0
161         1.0  1.0  1.0  2.0  2.0  3.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
170        15.5 13.0 15.5 17.0  9.0 15.5  9.0 13.0 13.0 13.0  9.0 16.0 16.5 16.0
171        16.0 15.0 14.5 13.5 13.5 13.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0  0.0
```

continued

```
PPRANK PROGRAM

VARIABLE NUMBER   1

SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK

  1  60.000000E-01   15.5            2  20.000000E-01    2.5            3  20.000000E-01    2.5            4  10.000000E-01    1.0
  5  40.000000E-01    9.0            6  40.000000E-01    9.0            7  70.000000E-01   17.0            8  60.000000E-01   15.5
  9  50.000000E-01   13.0           10  30.000000E-01    5.0           11  50.000000E-01   13.0           12  40.000000E-01    9.0
 13  30.000000E-01    5.0           14  40.000000E-01    9.0           15  50.000000E-01   13.0           16  40.000000E-01    9.0
 17  30.000000E-01    5.0

VARIABLE NUMBER   2

SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK

  1  60.000000E-01   15.5            2  60.000000E-01   15.5            3  20.000000E-01    2.5            4  70.000000E-01   17.0
  5  20.000000E-01    2.5            6  40.000000E-01    9.0            7  50.000000E-01   13.0            8  50.000000E-01   13.0
  9  40.000000E-01    9.0           10  50.000000E-01   13.0           11  40.000000E-01    9.0           12  30.000000E-01    5.0
 13  40.000000E-01    9.0           14  30.000000E-01    5.0           15  40.000000E-01    9.0           16  10.000000E-01    1.0
 17  30.000000E-01    5.0
       .                                 .                                 .                                 .
       .                                 .                                 .                                 .
       .                                 .                                 .                                 .
VARIABLE NUMBER  12

SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK          SUBJ       DATA          RANK

  1  50.000000E-01   13.0            2  60.000000E-01   15.5            3  30.000000E-01    5.0            4  50.000000E-01   13.0
  5  20.000000E-01    2.5            6  40.000000E-01    9.0            7  40.000000E-01    9.0            8  10.000000E-01    1.0
  9  70.000000E-01   17.0           10  30.000000E-01    5.0           11  40.000000E-01    9.0           12  40.000000E-01    9.0
 13  20.000000E-01    2.5           14  40.000000E-01    9.0           15  50.000000E-01   13.0           16  60.000000E-01   15.5
 17  30.000000E-01    5.0

VARIABLE NUMBER  13 IS THE CONSENSUS OF   3 VARIABLES.
  1   2   3

KENDALL W COEFICIENT=  .40486

TEST FOR SIGNIFICANCE---CHISQ=   19.4334 WITH 16 DEGREES OF FREEDOM.

SUBJ       SUMR          RANK          SUBJ       SUMR          RANK          SUBJ       SUMR          RANK          SUBJ       SUMR          RANK

  1  40.000000E+00   16.0            2  31.000000E+00   13.0            3  10.000000E+00    1.0            4  27.000000E+00   11.0
  5  14.000000E+00    2.0            6  27.000000E+00    7.0            7  43.000000E+00   17.0            8  29.500000E+00   12.0
  9  37.500000E+00   14.0           10  27.000000E+00    9.0           11  27.000000E+00    9.0           12  27.000000E+00    9.0
 13  16.500000E+00    4.0           14  23.000000E+00    5.0           15  39.000000E+00   15.0           16  25.500000E+00    6.0
 17  15.000000E+00    3.0
       .                                 .                                 .                                 .
       .                                 .                                 .                                 .
       .                                 .                                 .                                 .
VARIABLE NUMBER  22 IS THE CONSENSUS OF  12 VARIABLES.
  1   2   3   4   5   6   7   8   9  10  11  12

KENDALL W COEFICIENT=  .29168

TEST FOR SIGNIFICANCE---CHISQ=   56.0034 WITH 16 DEGREES OF FREEDOM.

SUBJ       SUMR          RANK          SUBJ       SUMR          RANK          SUBJ       SUMR          RANK          SUBJ       SUMR          RANK

  1  13.950000E+01   14.0            2  16.050000E+01   16.C            3  10.400000E+01    9.0            4  11.850000E+01   12.0
  5  50.500000E+00    1.0            6  92.000000E+00    6.0            7  10.950000E+01   10.0            8  97.500000E+00    7.0
  9  16.750000E+01   17.0           10  79.000000E+00    3.0           11  11.200000E+01   11.0           12  10.150000E+01    8.0
 13  81.500000E+00    5.0           14  81.500000E+00    4.0           15  14.250000E+01   15.0           16  12.900000E+01   13.0
 17  69.500000E+00    2.0
```

continued

```
CARD OUTPUT

  10       15.5 15.5  9.0  5.0 17.C  5.0 13.0 13.0 15.5  5.0 13.0 13.0 16.0 15.0
  11       15.0 13.5 13.0 13.0 14.0 14.0 14.0 14.0  0.0  0.0  0.0  0.0  0.0  0.0
  20        2.5 15.5 13.0 13.0 15.5 17.0 15.5 15.5 17.0  5.0 15.5 15.5 13.0 13.0
  21       14.0 15.0 16.0 17.0 17.0 16.0 16.0 16.0  0.0  0.0  0.0  0.0  0.0  0.0
  30        2.5  2.5  5.0 15.5 15.5 13.0  9.0 15.5  2.5  9.0  9.0  5.0  1.0  4.0
  31        8.0 10.0  9.0 11.0 10.0 10.0  9.0  9.0  0.0  0.0  0.0  0.0  0.0  0.0
  40        1.0 17.0  9.0  5.0  9.0  5.0 17.0  5.0  9.0 13.0 15.5 13.0 11.0  7.0
  41        7.0  5.0 10.0  9.0  9.0  9.0 12.0 12.0  0.0  0.0  0.0  0.0  0.0  0.0
  50        9.0  2.5  2.5  2.5  1.0  5.0  2.5  2.5  5.0 13.0  2.5  2.5  2.0  1.0
  51        1.0  1.0  1.0  1.0  1.0  1.0  1.0  1.0  0.0  0.0  0.0  0.0  0.0  0.0
  60        9.0  9.0  9.0  9.0  9.0  9.0  9.0  5.0  5.0  1.0  9.0  9.0  7.0  8.0
  61       10.0  9.0  8.0  8.0  8.0  5.0  6.0  6.0  0.0  0.0  0.0  0.0  0.0  0.0
  70       17.0 13.0 13.0  1.0  5.0  9.0 13.0 13.0  9.0  2.5  5.0  9.0 17.0 14.0
  71       12.0 11.0 12.0 12.0 12.0 11.0 10.0 10.0  0.0  0.0  0.0  0.0  0.0  0.0
  80       15.5 13.0  1.0  9.0  5.0  2.5  2.5  9.0  9.0 17.0 13.0  1.0 12.0 10.5
  81        9.0  6.0  6.0  7.0  6.0  8.0  8.0  7.0  0.0  0.0  0.0  0.0  0.0  0.0
  90       13.0  9.0 15.5 15.5 13.0 13.0  9.0 17.0 13.0 15.5 17.0 17.0 14.0 16.0
  91       17.0 16.0 15.0 16.0 15.0 17.0 17.0 17.0  0.0  0.0  0.0  0.0  0.0  0.0
 100        5.0 13.0  9.0  2.5  9.0  9.0  5.0  2.5  5.0  5.0  9.0  5.0  9.0  5.0
 101        5.5  7.5  7.0  5.0  4.0  3.0  4.0  3.0  0.0  0.0  0.0  0.0  0.0  0.0
 110       13.0  9.0  5.0 13.0  9.0 13.0  9.0  5.0 13.0  9.0  5.0  9.0  9.0 12.0
 111       11.0 12.0 11.0 10.0 11.0 12.0 11.0 11.0  0.0  0.0  0.0  0.0  0.0  0.0
 120        9.0  5.0 13.0  9.0  2.5  9.0  1.0  9.0 13.0 13.0  9.0  9.0  9.0  9.0
 121        5.5  7.5  5.0  6.0  7.0  7.0  7.0  8.0  0.0  0.0  0.0  0.0  0.0  0.0
 130        5.0  9.0  2.5  5.0 13.0  9.0  5.0  1.0  9.0 15.5  5.0  2.5  4.0  2.0
 131        4.0  4.0  4.0  3.0  3.0  6.0  5.0  5.0  0.0  0.0  0.0  0.0  0.0  0.0
 140        9.0  5.0  9.0  9.0  2.5  1.0  9.0  9.0  9.0  9.0  1.0  9.0  5.0  6.0
 141        3.0  3.0  3.0  4.0  5.0  4.0  3.0  4.0  0.0  0.0  0.0  0.0  0.0  0.0
 150       13.0  9.0 17.0 17.0  9.0 15.5 13.0  9.0 15.5  9.0  2.5 13.0 15.0 17.0
 151       16.0 17.0 17.0 15.0 16.0 15.0 15.0 15.0  0.0  0.0  0.0  0.0  0.0  0.0
 160        9.0  1.0 15.5 13.0 13.0 15.5 15.5 13.0  2.5  2.5 13.0 15.5  6.0 10.5
 161       13.0 13.5 14.0 14.0 13.0 13.0 13.0 13.0  0.0  0.0  0.0  0.0  0.0  0.0
 170        5.0  5.0  5.0  9.0  5.0  2.5  5.0  9.0  1.0  9.0  9.0  5.0  3.0  3.0
 171        2.0  2.0  2.0  2.0  2.0  2.0  2.0  2.0  0.0  0.0  0.0  0.0  0.0  0.0
                  .         .         .         .         .
                  .         .         .         .         .
                  .         .         .         .         .

                  .         .         .         .         .
```

Printout was terminated on 16th run owing to exceeding of line limit

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 28.459 seconds for central-processor time and 28.786 seconds for peripheral-processor time with a memory usage of 51,600 words. Chargeable computer time was $4.86.

Charge to user = computer time + postage and handling + network overhead
= $4.86 + $15.00 + network overhead
= $19.86 + network overhead

CONTENTS—PPRANK

pages

1	Identification & Abstract
3–6	User Instructions
7–11	I/O
13	Cost—Contents

DESCRIPTIVE TITLE	Rank-Order Statistics
CALLING NAME	RKSTAT NUCC020
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Vogelback Computing Center Northwestern University
LANGUAGE	CDC FORTRAN
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

RKSTAT ranks as many as 100 subjects on as many as 80 variables and calculates the following rank-order statistics that compare the ranks assigned to two or more variables: Wilcoxon—Mann—Whitney U, Kruskal—Wallis H, Spearman rank correlation coefficient RS, Kendall coefficient of concordance W. Sample values for these statistics are printed out with directions for the testing of their significance.

The statistical comparison tests in this category assume that the raw data have only the strength of *ordinal* measurement. A raw-data observation is assigned a *rank* that is given by one plus the number of observations that are numerically smaller than it (if IRANK = 0) or numerically larger than it (if IRANK = 1). In calculating the statistics in these tests, the ranks are treated as interval measurements without implying that the raw data have the strength of an interval scale. These statistics universally assume *underlying continuity*; therefore, the probability of a tie in the raw data is zero. When a tie does occur, however, it is immediately assumed that the tie is an illusion produced by inaccurate measurement and each tied observation is assigned the average of the ranks available to the tied observations. For example, if a single observation of 1.53 has been assigned the rank 9 and four observations are tied at 1.54, each of the four tied observations

continued

will be assigned the rank 11.5 and any single observation occurring at 1.55 would get the rank 14.

Wilcoxon–Mann–Whitney U Statistic Test—compares two, independent samples of equal or unequal size. The U test is more sensitive to differences in location (central tendency) than to differences in dispersion or skewness. The Kolmogorov–Smirnov D test is more suitable than the U test if one wishes to test for *all* kinds of differences.

For fixed, small α, the power efficiency of the U test, as compared with the t test, approaches 95.5% (i.e., $3/\pi \times 100$) as N approaches infinity. This shows that the U test is very powerful for large samples and even moderately sized samples.

Kruskal–Wallis H Statistic Test—compares k independent samples of equal or unequal length. Like the U test, the H test is primarily a test of location.

For fixed small α, the H test, as compared with the F test, has an asymptotic efficiency of 95.5% (i.e., $3/\pi \times 100$).

Spearman Rank Correlation Coefficient RS—gives the correlation between two matched samples (of equal length N).

The Spearman RS has approximately 91% power efficiency when compared with the Pearson r (i.e., when the matched data are, in fact, taken from a bivariate normal distribution, are measured on an interval scale, and are correlated in the population, then r will detect this correlation at the significance level with 91 observations for every 100 observations that are required to detect this correlation at this significance level by RS).

Kendall Coefficient of Concordance W—gives the correlation between k matched samples of equal length N. *Note:* a significant W does not imply that the rankings are objective or "right," but only "consensual." I.e., each sample appears to have its observations ranked on the same (possible erroneous) criteria.

The power of W is 91% as compared to the average of the pairwise Pearson r correlations of the k samples.

Interested persons are directed to the source listed in the Reference for a fuller mathematical explanation of the various tests.

REFERENCE

Siegel, S., *Nonparametric Statistics* (McGraw–Hill Book Co., Inc., New York, 1956).

USER INSTRUCTIONS

Description of Input Data

The word *group* signifies a number of subjects who are considered homogeneous. Each of these subjects has a number of (NVARS) of variables punched upon its set of cards. Frequently, a set is one card only. A total of NGRPS groups are read in. *Example:* if NVARS = 3 and NGRPS = 2, then 3 variables (age, weight, IQ) could be entered for 63 men (group 1) and 37 women (group 2). A set could consist of one card upon which is punched the subject's identification (this will not be read by the computer), his age, weight, and IQ.

A *sample* consists of the data on *one* variable for *all* the subjects in *one* group. The program refers to the samples in such a way that the variables of a group are numbered successively; i.e., in the above example, sample 1 consists of the ages of the 63 male subjects, sample 2 is the weights of the 63 male subjects, sample 3 is the IQ of the 63 male subjects, sample 4 is the ages of the 37 female subjects, etc. Thus, a U test between samples 1 and 4 will compare the ranks assigned to the ages of male and female subjects to see if the ages come from different populations. Samples 1 and 4 may not be correlated with an RS coefficient in the above example because the samples have a different number of subjects (63 ≠ 37). An RS between samples 1 and 3 would indicate if the IQ of male subjects increases or decreases with age.

Problem Card

Columns	*Parameter*	*Contents*
1– 6		*INPUT
7– 8	NVARS	Number of variables measured on each group (1≤NVARS≤80)
9–10	NGRPS	Number of groups (1≤NGRPS≤20)
11	NFMT	Number of Variable-Format Card(s) to be read preceding each group (1≤NFMT≤9)
12–14	MOBS (1)	Number of subjects in group 1 (1≤MOBSC1)≤100)
15–17	MOBS (2)	Number of subjects in group 2 (1≤MOBSC2)≤100)
⋮	⋮	⋮
13	MOBS (NGRPS)	Number of subjects in last group

continued

Note:

Samples 1 through NVARS will have MOBS (1) observation.
Samples NVARS +1 through 2*NVARS will have MOBS (2) observations.
Samples 2*NVARS +1 through 3*NVARS will have MOBS (3) observations.
⋮ ⋮ ⋮

Variable-Format Card(s)

Columns	*Parameter*	*Contents*
1– 6		*FORMAT on each card used
7–72	FMT (I)	Specify the format in the group that follows

The same format frequently is used for all the groups, but a number of Format Cards equal to NFMT must still be read preceding each group.

Setup Card(s)

Columns	*Parameter*	*Contents*
1– 6		*SETUP
7		Blank
8–13	IDENT	Punch six alphanumeric characters to identify the test about to be performed
14	IRANK	Controls the assignment of ranks; assignment order of ranks will be the same for all variables as specified by IRANK. =1: the larger the sample value, the lower the rank ≠1: the smaller the sample value, the lower the rank
15	NTYPE	=1: specifies U or H test =2: specifies an RS or W coefficient anything else is meaningless
16–17	NSMPLS	≤1: meaningless =2: specifies U test or RS coefficient =K: specifies a H or W coefficient ($2<K\le30$) >30: meaningless

continued

	Note:	*With NTYPE and NSMPLS both specified only one test or coefficient can be calculated per Setup Card*
18–19	NUMSP (1)	Sample number of 1st sample to be used
20–21	NUMSP (2)	Sample number of 2nd sample to be used
⋮	⋮	⋮
.	NUMSP (NSMPLS) I2	Sample number of last sample to be used

Note: 1<NUMSP(I)≤NVARS X NGRPS If an IDENT of all dollar signs (i.e., $$$$$$) is specified, a standard setup will be performed in which NSMPLS is equal to NGRPS. Thus, and IDENT of all dollar signs cannot be used if NGRPS = 1. In the standard setup, the values of IRANK and NTYPE are read off the *Setup Card and everything following Col. 15 will be ignored. The program then performs NVARS calculation as if NVARS Setup Cards had been read. *Example:* if NVARS = 4, NGRPS = 2, and NTYPE = 2, four Spearman rank correlation coefficients will be calculated. The first will correlate samples 1 and 5, the second -2 and 6, the third -3 and 7, and the fourth -4 and 8. The above assumes that MOBS(1) = MOBS(2). Even if MOBS(1) ≠ MOBS(2), NTYPE could be set equal to 1 and Mann–Whitney U tests would be performed between the four pairs of samples, one sample of each pair from each group.

Finish Card

Columns	*Parameter*	*Contents*
1- 6		*FINIS

A Finish Card is inser~~ted~~ only when you wish to start over (i.e., a Finish Card is followed by a new Problem Card).

Description of Output

Lines	
1	The IDENT and IRANK, NTYPE, NSMPLS; latter two tell which test will be used
2	Sample numbers to be used; the number of these will be NSMPLS
3	Tells what test is being applied
4,5	Give calculated value of the statistic and value corrected for ties

continued

6 Tells with how many degrees of freedom the statistic approaches χ^2

7 Tells how many groups there are

For each trial, the samples are then ranked, giving the sample number, number of observations, sample rank, and, following this, the observed values and their ranks within the trial. After these, the number of tied observations are listed along with the number of times that each tie is found in the trial.

Limitations

Maximum number of subjects 100
Maximum number of variables 80
$2 < NVARXNGRPS \leq 80$
Number of samples = k: $(2 < k < 30)$
$1 \leq NUMSP(I) \leq NVARSXNGRPS$

Job Deck Structure

```
Job Card
LIBRARY (RKSTAT)
LGO.
7-8-9 EOR
  Problem Card (*INPUT)                                    --+  repeat for each problem
                       NFMT Variable-Format Cards      --+   |
                       MOBS(1) sets of Data Cards for    | repeat for each group
                        Group                          --+   |
       :                        :                            |
  Setup Card(s)        (*SETUP); use as many as needed       |
                       to specify the calculations you       |
                       wish to perform                       |
  Finish Card          (*FINIS); omit if there is only       |
                       one problem                           |
6-7-8-9 EOI                                                --+
```

SAMPLE INPUT

```
VLOER.[redacted].CM61100.   RKSTAT
LIBRARY(RKSTAT)
LGO.
*INPUT11061011005006004007005
*FORMT(11X,6F2.0,5F3.0)
7311L207.91151213140814111116118101085
7401L207.31080814110810111120095097106
6791L207.72090709070809079075087088084
6141L206.71060706040608075081074082088
6451L208.81100906061206091097086074064
6481L211.11120712081010104109095086083
4911L207.52120808090812086079097077080
6181L207.81111213110515106103108085072
4681L208.01111106050806082082085075093
6921L207.11120912141711112104118138081
6761L207.81171112091009103096110090093
*FORMT(11X,6F2.0,5F3.0)
4881L318.311315161210  111103122102072
6111L316.111110814120  118125106100062
6541L313.61101116121716117108125096081
6821L309.22080709071409090089093079091
7061L311.01120910131109103101104068086
*FORMT(11X,6F2.0,5F3.0)
4621L409.42081511100910093084104103094
5321L412.31070908050407080086076065079
5071L412.21161314081315130131122095075
5161L408.62070805090506079084076067075
7521L411.51131211151408105095115078087
6871L411.91171310090910107104110094081
*FORMT(11X,6F2.0,5F3.0)
6561L511.01100905060810091097084061071
6951L511.1113131310807095086106061084
7561L511.01120914091407107108106080079
7761L509.92080712111007092091094061076
*FORMT(11X,6F2.0,5F3.0)
4691L607.81081212121111098090107093102
5141L609.61111012110909099095103080104
5341L607.11091415110815119120114095109
5741L610.31090810090312077070090053061
6371L614.61120808090916107110103093071
6811L606.71040205010005057070051068069
7021L609.61181113140807102092113093081
*FORMT(11X,6F2.0,5F3.0)
4601L709.61111009120710094091099076095
4821L715.71100607070105079089072069056
5151L711.41131009120508087080097064091
6351L712.31151311081010119125108077078
7651L707.61120810090811088081097089100
*SETUP KWHTES2106011223344556
*SETUP KWHTES2106021324354657
*SETUP KWHTES2106031425364758
*SETUP KWHTES2106041526374859
*SETUP KWHTES2106051627384960
*SETUP KWHTES2106061728395061
*SETUP KWHTES2106071829405162
*SETUP KWHTES2106081930415263
*SETUP KWHTES2106092031425364
*SETUP KWHTES2106102132435465
*SETUP KWHTES2106112233445566
*FINIS
*INPUT08061011005006004007009
*FORMT(11X8F3.0)
7312L207.91130092120108106114105049
7402L207.31127093100103095100077049
             .    .    .     .
             .    .    .     .
             .    .    .     .

             .    .    .     .
```

SAMPLE OUTPUT

```
TRIAL IDENTIFICATION KRUTES          IRANK= 0 NTYPE= 1 NSMPLS= 6
THE SAMPLE NUMBERS ARE   1 12 23 34 45 56
APPLY KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE


H=  1.7201202E+00
HP=  1.7435868E+00 CORRECTED FOR TIES
IS CHI-SQ DISTRIBUTED WITH  5 DEGREES OF FREEDOM



THERE ARE  6 GROUPS


SAMPLE NUMBER  1 HAS  11 OBSERVATIONS. THE SAMPLE RANK IS   217.50

     OBSERVATION     RANK       OBSERVATION     RANK       OBSERVATION     RANK       OBSERVATION     RANK
   1.5000000E+01     33.5     8.0000000E+00      7.0     9.0000000E+00     11.0     6.0000000E+00      2.0
   1.0000000E+01     14.5     1.2000000E+01     25.0     1.2000000E+01     25.0     1.1000000E+01     19.0
   1.1000000E+01     19.0     1.2000000E+01     25.0     1.7000000E+01     36.5
                            :                        :                        :

SAMPLE NUMBER 56 HAS   5 OBSERVATIONS. THE SAMPLE RANK IS   122.50

     OBSERVATION     RANK       OBSERVATION     RANK       OBSERVATION     RANK       OBSERVATION     RANK
   1.1000000E+01     19.0     1.0000000E+01     14.5     1.3000000E+01     30.5     1.5000000E+01     33.5
   1.2000000E+01     25.0


THERE ARE   9 TIED OBSERVATIONS

     OBSERVATION     TIES       OBSERVATION     TIES       OBSERVATION     TIES       OBSERVATION     TIES
   1.5000000E+01        2     8.0000000E+00        5     9.0000000E+00        3     1.0000000E+01        4
   1.2000000E+01        7     1.1000000E+01        5     1.7000000E+01        2     1.3000000E+01        4
   7.0000000E+00        2
```

continued

000 0031

```
TRIAL IDENTIFICATION  KWTIES          IRANK= 0 NTYPE= 1 NSMPLS= 6
THE SAMPLE NUMBERS ARE   8 16 24 32 40 48
APPLY KRUSKAL-WALLIS ONE-WAY ANALYSIS OF VARIANCE

H=  2.9903250E+00
HP=  2.9942566E+00 CORRECTED FOR TIES
IS CHI-SQ DISTRIBUTED WITH  5 DEGREES OF FREEDOM


THERE ARE  6 GROUPS


SAMPLE NUMBER  8 HAS  11 OBSERVATIONS. THE SAMPLE RANK IS   185.50

    OBSERVATION     RANK      OBSERVATION     RANK      OBSERVATION     RANK
   4.9000000E+01    16.5     4.9000000E+01    16.5     3.5000000E+01    10.0     2
   5.0000000E+00     1.0     9.1000000E+01    31.0     4.1000000E+01    13.0     5
   7.7000000E+01    26.5     5.1000000E+01    18.0     7.9000000E+01    28.0
                         :                        :                        :

SAMPLE NUMBER 48 HAS   5 OBSERVATIONS. THE SAMPLE RANK IS   100.50

    OBSERVATION     RANK      OBSERVATION     RANK      OBSERVATION     RANK      OBSERVATION     RANK
   9.3000000E+01    32.0     2.4000000E+01     4.0     3.3000000E+01     7.5     1.3100000E+02    38.0
   5.7000000E+01    19.0


THERE ARE   6 TIED OBSERVATIONS

    OBSERVATION     TIES      OBSERVATION     TIES      OBSERVATION     TIES      OBSERVATION     TIES
   4.9000000E+01       2     3.5000000E+01       3     7.7000000E+01       2     9.5000000E+01       3
   3.3000000E+01       2     4.3000000E+01       2
```

000 0031

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 4.252 seconds for central-processor time and 20.582 seconds for peripheral-process time with a memory usage of 61,100 words. Chargeable computer time was $1.19.

Charge to user = computer time + postage and handling + network overhead
= $1.19 + $15.00 + network overhead
= $16.19 + network overhead

CONTENTS—RKSTAT

pages
1,2 Abstract & Identification
3–6 User Instructions
7–9 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Sequence Checking
CALLING NAME	SEQCHK NUCC078
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Betty Benson, Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

Inasmuch as the data for each of a number of subjects or cases in an analysis may occupy several cards, it is clearly necessary that these data cards be read in the same order for each case. SEQCHK checks to see if a data deck (or a data tape) contains the correct number of cards, in the correct order, for each case, up to a maximum of 9999 cases. An appropriate error message is printed whenever a card is found out of order or if any cards are missing.

USER INSTRUCTIONS

Description of Input Data

Control Card A

Columns	
1	0 or blank if *case* number occurs before *card* number on each data card 1 if *card* number occurs before *case* number on each data card
2	0 or blank if input is from card 1 if input is from data tape
3– 5	Number of cards/case (≤ 100)
6–45	Format to read in case number and card number (I-type specifications)

Example: Card number is in Cols. 1–2 and case number is in Cols. 76–80. User should punch, beginning in Col. 6, the following format: (I2, 73X, I5)

Control Card(s) B (1–4 cards)

Each of cards B consists of 25 fields of 3 columns each. These fields contain the list of card numbers to be expected, *in the order in which they are expected.*

Consecutive data cards need not be sequentially numbered. User X, e.g., may have cards 1, 2, 3, 4, 5, in that order. User Z might have cards 80, 81, 3, 17, 4, 12, and 69, in that order. User Z should punch his single card B as follows:

80 in Cols. 2–3; 81 in Cols. 5–6; 3 in Col. 9···; 69 in Cols. 20–21

Unless the data are on tape, the data deck follows card B.

Description of Output

A message will be printed whenever there is a missing card, an extra card, cards out of order, or any combination of input that does not exactly match what is expected. A count of the cards read and the total number of cases checked will also be printed out at the end.

continued

Job Deck Structure

```
            Job Card
If data     REQUEST (TAPE1, HI)        HANG REEL xxxx
on tape
            LIBRARY(SEQCHK)
            LGO.
            (7-8-9) (EOR card)
                      (Program control cards)
                      Control card A
                      Control card B
                      Data (if on cards)
            (6-7-8-9) (EOI card)
```

Note: If data tape was written by a machine other than the CDC 6400, it would be necessary to substitute REQUEST (TAPE1,d,X) HANG REEL xxxx, where d is the tape density.

SAMPLE INPUT

```
VLCRR.[redacted].5,20000.    SEQCHK
LIBRARY(SEQCHK)
LGO.
00   5(4I3,I1)
  1  2  3  4  6
 1001
 1002
 1003
 1004
 1006
 1011
 1012
 1014
 1016
 1021
 1022
 1023
 1025
 1026
 1031
 1032
 1033
 1033
 1034
 1036
 1041
   .
   .
   .
 1095
 1101
 1102
 1113
 1104
 1106
 1111
 1112
 1103
 1114
 1116
 1122
 1123
 1124
 1126
 1131
 1132
 1133
 1134
 1136
 1131
 1132
 1133
 1134
 1136
 1141
 1142
 1143
 1144
 1151
 1152
 1153
 1154
 1156
```

SAMPLE OUTPUT

```
                    FORMAT  (XI3,I1)

                     5 CARDS PER OBSERVATION. CARDS TO BE NUMBERED AS SHOWN BELOW
                     1   2   3   4   6

OBS.    101...CARD  4    (CARD  3 WAS EXPECTED)
OBS.    101...CARD  6    (CARD  4 WAS EXPECTED)
OBS.    101 HAS  4 CARDS
OBS.    102...CARD  5    (CARD  4 WAS EXPECTED)
OBS.    103...CARD  3    (CARD  4 WAS EXPECTED)
OBS.    103...CARD  4    (CARD  6 WAS EXPECTED)
OBS.    103...CARD  6   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    103 HAS  6 CARDS
OBS.    104...CARD  5    (CARD  6 WAS EXPECTED)
OBS.    104...CARD  6   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    104 HAS  6 CARDS
OBS.    105...CARD  4    (CARD  3 WAS EXPECTED)
OBS.    105...CARD  3    (CARD  4 WAS EXPECTED)
OBS.    106...CARD  7    (CARD  6 WAS EXPECTED)
OBS.    107...CARD  3    (CARD  2 WAS EXPECTED)
OBS.    107...CARD  4    (CARD  3 WAS EXPECTED)
OBS.    107...CARD  5    (CARD  4 WAS EXPECTED)
OBS.    108...CARD  3    (CARD  2 WAS EXPECTED)
OBS.    108...CARD  2    (CARD  3 WAS EXPECTED)
OBS.    108...CARD  7   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    108...CARD  6   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    108 HAS  7 CARDS
OBS.    109...CARD  5    (CARD  6 WAS EXPECTED)
OBS.    110 HAS  2 CARDS
OBS.    111...CARD  3    (CARD  1 WAS EXPECTED)
OBS.    111 HAS  1 CARDS
OBS.    110...CARD  4    (CARD  1 WAS EXPECTED)
OBS.    110...CARD  6    (CARD  2 WAS EXPECTED)
OBS.    110 HAS  2 CARDS
OBS.    111 HAS  2 CARDS
OBS.    110...CARD  3    (CARD  1 WAS EXPECTED)
OBS.    110 HAS  1 CARDS
OBS.    111...CARD  4    (CARD  1 WAS EXPECTED)
OBS.    111...CARD  6    (CARD  2 WAS EXPECTED)
OBS.    111 HAS  2 CARDS
OBS.    112...CARD  2    (CARD  1 WAS EXPECTED)
OBS.    112...CARD  3    (CARD  2 WAS EXPECTED)
OBS.    112...CARD  4    (CARD  3 WAS EXPECTED)
OBS.    112...CARD  6    (CARD  4 WAS EXPECTED)
OBS.    112 HAS  4 CARDS
OBS.    113...CARD  1   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    113...CARD  2   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    113...CARD  3   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    113...CARD  4   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    113...CARD  6   EXTRA CARD OR ILLEGAL CARD NO.
OBS.    113 HAS 10 CARDS
OBS.    114 HAS  4 CARDS

     86 CARDS              [illegible] OBSERVATIONS
```

COST ESTIMATE

For the job listed in the Sample Input, the total running time was 0.339 seconds for central-processor time and 15.823 seconds for peripheral-processor time with a memory usage of 20,000 words. Chargeable computer time was $1.00 (NU minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—SEQCHK

pages
1 Identification & Abstract
3–4 User Instructions
5–6 I/O
7 Cost—Contents

DESCRIPTIVE TITLE	Interrupt Time Series—Three Tests of Significance
CALLING NAME	TIMEX NUCC049
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Joyce Sween, Department of Sociology, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

TIMEX performs three statistical tests on data of the interrupted time-series form: (1) the Mood test, (2) the Walker—Lev covariance tests, and (3) double extrapolation.

In addition to the T or F values of each statistical test of significance, the following information may be obtained (options to be indicated on card input).

Mood Test

Standard error for t test
Estimated y value for the first postchange point
Obtained y value for the first postchange point
Slope and intercept for the prechange points
Variance of the obtained prechange points from the regression estimated values

Walker—Lev Tests

Test 1

Numerator and denominator sum of squares for F
Regression estimates (slope and intercept) for prechange values

continued

Estimated y value at experimental change (i.e., midway between last pre- and first post-change points), based upon prechange regression estimates
Regression estimates for postchange values
Estimated y value at experimental change, based upon postchange regression estimates
Common within-groups regression estimates for the pre- and post-change values
Estimated y value at experimental change, based upon each of the above regression estimates

Test 2

Numerator and denominator sum of squares for F

Test 3

Numerator and denominator sum of squares for F
Regression estimates (slope and intercept) for the total series
Estimated y value at experimental change, based upon the above regression estimates

Double-Extrapolation Technique for Mood Test

Standard error for T test
Regression estimates for pre- and post-change values
Variance of the obtained pre- and post-change points from the values predicted on the basis of the above regression estimates
Estimated y value at experimental change based upon pre- and post-change regression estimates

A data plot of the time series may also be obtained.

REFERENCES

Sween, J., and Campbell, D.T., "A Study of the Effect of Proximally Autocorrelated Error on Tests of Significance for the Interrupted Time Series Quasi-Experimental Design," Northwestern Univ. (Aug. 1965; unpublished).

Sween, J., and Campbell, D.T., "The Interrupted Time Series as Quasi-Experiment: Through Tests of Significance," Northwestern Univ. (Aug. 1965; unpublished).

USER INSTRUCTIONS

Description of Input Data

Title Card

Columns	*Contents*
1–80	Identifying alphanumeric information (to appear as a heading on the printout and on the data plot)

Occasion Card

Columns	*Contents*
1– 3	Total number of occasions (maximum:400) in the time series. The number of occasions in the pre- and post-change groups must be specified in Cols. 4–9. (TIMEX assumes that the y or occasion values occur at equal intervals in time.)
4– 6	Number of occasions in the prechange group
7– 9	Number of occasions in the postchange group

Test-Specification Card

Columns	*Contents*
1	= 1 if calculations of serial correlation coefficients are desired = 0 (or blank) if *not* desired
2	= 1 if the Mood test is desired = 0 (or blank) if *not* desired
3	= 1 if the Walker–Lev covariance tests are desired = 0 (or blank) if *not* desired
4	= 1 if the "double-extrapolation" technique for a double Mood test is desired = 0 (or blank) if *not* desired
5	= 1 if the information specified in the Functional Abstract is to be printed out for *each* test of significance specified above = 0 (or blank) if you wish to have only the T or F values and the df for each test of significance (The additional information is *not* printed out)

continued

Columns	*Contents*
6	= 1 if a data plot of input data points is desired = 2 if it is desired that terminal points for the regression lines based on pre- and post-change values and on the total series be indicated on the plot = 0 (or blank) if the data plot is *not* desired

Variable-Format Card

Columns	*Contents*
1–80	Format specification (to be started in Col. 1 and to be completed in 80 columns). The statement is enclosed by parentheses. The word FORMAT is not used; otherwise the format specification is as described in the FORTRAN manual. Only F and X conversion is allowed. This card precedes the first Data Card.

Data Cards

The Data Cards must follow the Variable-Format Card. The data arrangement on each card must be that given by the format specifications on the Variable-Format Card.

Description of Output (see also Additional Information)

TIMEX calculates autocorrelation coefficients for lags 1 through 4. The autocorrelations are given also for the departures from the regression line, based on the total series and from the separate regression lines for the pre- and post-change values.

A data plot of the time series may also be obtained. Pre- and post-change observation values are indicated by separate plotting characters. If desired initial and terminal points for regression lines based on the pre- and post-change values and on the total series are indicated on the plot.

Results of the statistical tests are given as indicated in the Functional Abstract.

Error Indications

Errors in specification card will cause a printout to that effect.

Limitations

The total number of occasion values must not be greater than 400. The data plot will not indicate more than 25 pre- and/or 25 post-data points.

continued

Additional Information

If a 2 is placed in Col. 6 of the Test-Specification Card, initial and terminal points for the regression lines based on pre- and post-change values and on the total series are indicated on the data plot. The printing characters for the regression estimates are as follows.

, prechange . postchange *total series

Because the plotting subroutine can print only one point at a particular coordinate location, some data points will be missing from the plot. The location of the missing data points usually can be determined directly, as indicated in the following.

Missing Total Regression Estimates (*)

The *intial point* for the total series regression line is located at time t_1. If there are more than 25 prechange points, the point is located at time t_{N_1-24}. If the initial point for the total regression line is not plotted, it is located at the first plotted prechange occasion value (0).

The *terminal point* for the total series regression line is located at time t_{N_2}. If there are more than 25 postchange points, the point is located at time t_{N_1+25}. If the terminal point for the total regression line is not plotted, it is located at the last plotted postchange occasion value (X).

Missing Prechange Regression Estimates (,)

The *initial point* for the prechange regression line is located at t_1. If there are more than 25 prechange points, the point is located at time t_{N_1-24}. If the initial prechange regression estimate is not plotted *and* if the initial total regression estimate is not plotted, the initial prechange regression estimate is located at the first plotted occasion value (0). However, if the inital total regression estimate *is* plotted, additional information is needed to locate the missing point (it may be at * or 0): namely, the location of the missing point must be determined from the slope and intercept of the regression line.

The *terminal point* for the prechange regression line is located at time t_{N_1}. If this point is missing, it is located at the last prechange value (0).

continued

Missing Postchange Regression Estimates (.)

The *initial point* for the postchange regression line is located at time t_{N1+1}. If the point is missing, it is located at the first postchange occasion value (X).

The *terminal point* for the postchange regression line is located at time t_{N_2}. If there are more than 25 postchange points, the point is located at t_{N1+25}. If the terminal point for the postchange regression line is not plotted *and* if the terminal point for the total regression line is not plotted, the missing postchange regression estimate is located at the last plotted occasion value (X). However, if the total terminal regression estimate *is* plotted, additional information is need to locate the missing point (it may be at X or *): namely, the correct location for the missing point must be determined from the slope and intercept of the regression line.

Job Deck Structure

```
Job Card
LIBRARY(TIMEX,SETPLOT)
LGO.
EOR Card (7–8–9 multipunch in Col. 1) ┐
        Title Card                    │  may be
        Occasion Card                 │  repeated
        Test-Specification Card       │  for
        Variable-Format Card          │  additional
        Data Cards                   ─┘  problems
EOI Card (6–7–8–9 multipunch in Col. 1)
```

SAMPLE INPUT

```
VLORR,CH[redacted],CM34400.    TIMEX
LIBRARY(TIMEX,SETPLOT)
'LGO.
  TLE FOR THE TIMEX SAMPLE DATA
   10 10
    .
   5.1)
  30   52   43   53   63   20   12   45   78   56   85   96   23   85   23   3
  45   25   16   89
```

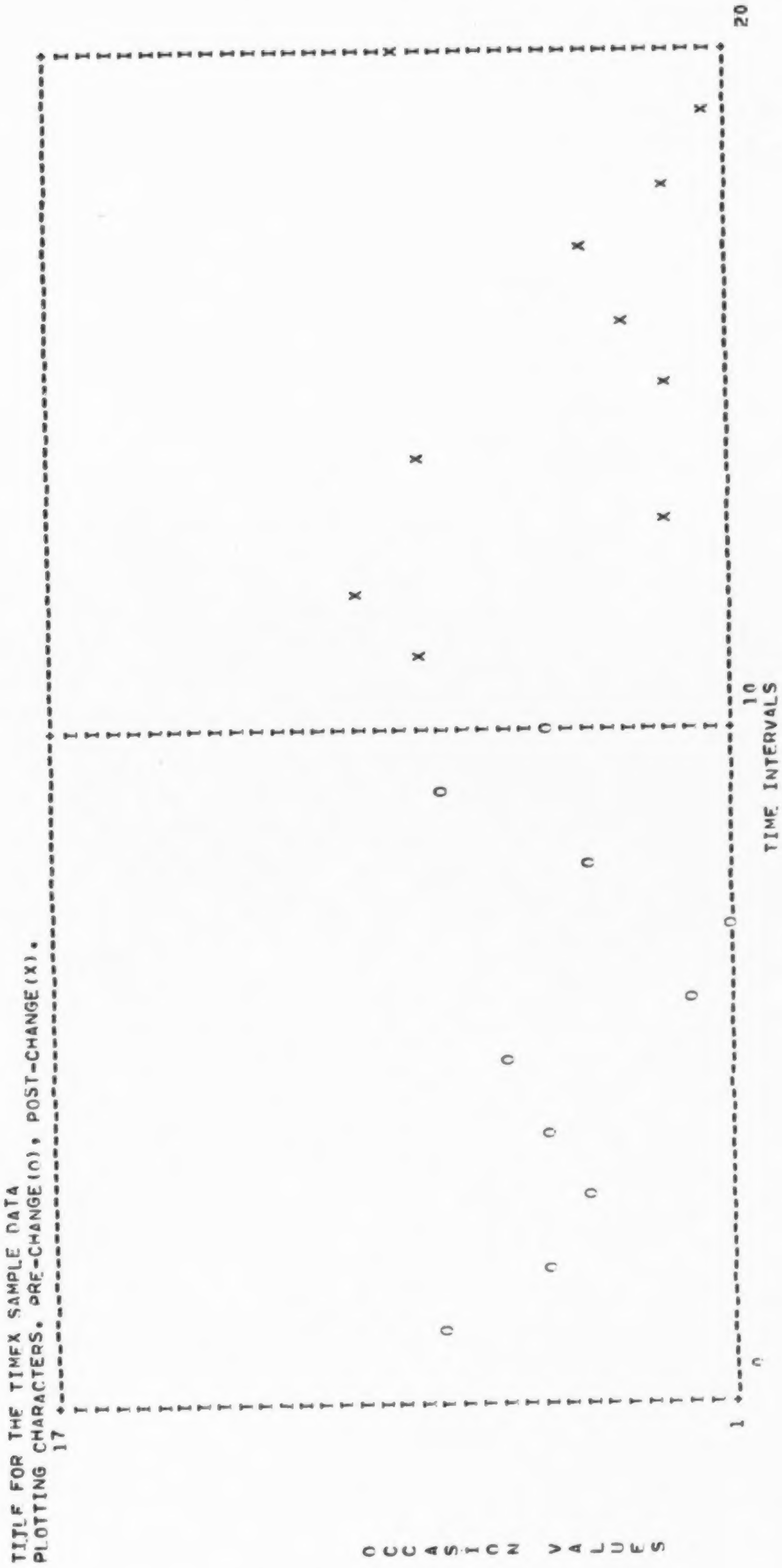
SAMPLE OUTPUT

```
TITLE FOR THE TIMEX SAMPLE DATA

PRE-EXPERIMENTAL OCCASION VALUES
     8.00      5.20      4.30      5.30      6.30      2.00      1.20      4.50      7.80      5.60
POST-EXPERIMENTAL OCCASION VALUES
     8.50      9.60      2.30      8.50      2.30      3.50      4.50      2.50      1.60      8.90

SERIAL CORRELATION COEFFICIENTS
     SLOPE AND INTERCEPT REMOVED (TOTAL REGRESSION ESTIMATE)
R(1)=  -.03   R(2)=  -.00   R(3)=   .11   R(4)=  -.29
     SLOPE AND INTERCEPT REMOVED (SEPARATE PRE AND POST REGRESSION ESTIMATES)
R(1)=  -.16   R(2)=  -.07   R(3)=   .02   R(4)=  -.22
     SLOPE AND INTERCEPT NOT REMOVED
R(1)=  -.01   R(2)=   .20   R(3)=   .11   R(4)=  -.29

WALKER-LEV TESTS
   TEST 1            F=    .36    DF=1, 16
     NUMERATOR SS=             2.83    DENOMINATOR SS=         125.65
     SEPARATE GROUP REGRESSION ESTIMATES
        PRE-X GROUP     SLOPE=          -.115   INTERCEPT=         5.653
                             ESTIMATED Y VALUE AT X=        4.44
        POST-X GROUP    SLOPE=          -.377   INTERCEPT=        11.063
                             ESTIMATED Y VALUE AT X=        7.10
     COMMON WITHIN GROUPS REGRESSION ESTIMATES
        PRE-X GROUP     SLOPE=          -.246   INTERCEPT=         6.373
                             ESTIMATED Y VALUE AT X=        3.79
        POST-X GROUP    SLOPE=          -.246   INTERCEPT=         9.034
                             ESTIMATED Y VALUE AT X=        6.45
   TEST 2            F=   1.24    DF=1, 16
     NUMERATOR SS=          1648.36    DENOMINATOR SS=       21199.52
   TEST 3            F=   1.16    DF=1, 17
     NUMERATOR SS=             8.78    DENOMINATOR SS=         128.48
     COMBINED GROUPS REGRESSION ESTIMATE
        TOTAL GROUP     SLOPE=          -.046   INTERCEPT=         5.603
                             ESTIMATED Y VALUE AT X=        5.12

DOUBLE MOOD TEST     T=   1.06    DF= 16
   STANDARD ERROR=          2.52
   PRE-X GROUP    SLOPE=          -.115   INTERCEPT=         5.653
           VARIANCE=               4.21   ESTIMATED VALUE Y=          4.44
   POST-X GROUP   SLOPE=          -.377   INTERCEPT=        11.063
           VARIANCE=               8.36   ESTIMATED VALUE Y=          7.10
```

continued

2

TITLE FOR THE TIMEX SAMPLE DATA
PLOTTING CHARACTERS, PRE-CHANGE(O), POST-CHANGE(X).



COST ESTIMATE

For the job listed on the Sample Input, the total running time was 0.606 seconds for central-processor time and 18.331 seconds for peripheral-processor time with a memory usage of 34,400 words. Chargeable computer time was $1.00 (NU minimum job charge).

Charge to user = computer time + postage and handling + network overhead

= $1.00 (NU minimum) + $15.00 + network overhead

= $16.00 + network overhead

CONTENTS—TIMEX

pages	
1,2	Identification & Abstract
3–6	User Instructions
7–9	I/O
11	Cost—Contents

/

DESCRIPTIVE TITLE	Information Retrieval System for Creating, Maintaining, Indexing, and Retrieving from Files of Textual Information
CALLING NAME	TRIAL NUCC118
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	**Donald Dillaman** **Lorraine** Borman, Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 **Tel.: (312) 492-3682**

FUNCTIONAL ABSTRACT

TRIAL is an information-processing system that will perform editing, indexing, and retrieval of textual and certain types of numeric information. The system allows for the creation and maintenance of a master file (EDIT), indexing on words designated as *key* words or, alternatively, on every word in the text, excluding those common terms that are user-supplied as a "stop" word list (INDEX), and computer retrieval and printout of entries that satisfy a user search command (SEARCH). The system is designed such that any one or any combination of the above features can be achieved through one computer run with proper control cards.

The system is sufficiently flexibe to handle diverse applications in information retrieval. TRIAL has been successfully used at Northwestern in such applications as a "Selective Dissemination of Information" (SDI) system, which automatically notifies social scientists of new journal articles that appear to fit their personal interests, and as a way to select students for overseas work, by retrieving from personnel files those individuals whose backgrounds satisfied the requirements of the project. The system is especially adaptable to large masses of bibliographic data where either selective bibliographies or various forms of indexes are desired.

continued

TRIAL is actually a series of six programs—TRIAL, EDIT, SEARCH, INDEX, SORTER, and PRINT—which, respectively, function as the Executive (issuing calls to other programs as needed), the Editor (processing new input data and updating the old), the Searcher (finding instances of given key words), the Selector (retrieving and indexing key words and their contexts), the Sorter (sorting the information file), and the Printer (controlling the numerous output options).

The TRIAL file structure allows for a maximum of nine levels of record definition within an entry; an entry is considered to be all of the information for one unit of analysis. Individual applications may utilize from one to all nine designated levels of information. Any level may have new information added to it, or, if the original design of the structure needs change, new levels may be added to the existing file.

Any master file created by the EDIT program can be searched. The important features of the SEARCH program are (1) its ability to search textual material for specified words or combinations of related key words and (2) its use of the Boolean operators, AND, OR, and NOT, giving the user the ability to specify how these key words must appear in combination with each other. If the user does not retrieve relevant documents, he may rephrase his command in much the same manner as does the user of a library card catalog.

Key-word indexing by computer is an automatic method for generating alphabetized listings of key words contained in input material. Input to the INDEX overlay of the TRIAL system is any file that has been created by the EDIT program, either in the same or a previous computer run. Two major options allow for completely general and lucid indexing of key words.

REFERENCES

Janda, K., and Tetzlaff, W.H.,"TRIAL: A Computer Technique for Retrieving Information from Abstracts of Literature," Behavioral Sci., *11* (Nov. 1966).

Janda, K., and Rader, G.,"Selective Dissemination of Information: A Progress Report from Northwestern University," Amer. Behavioral Sci., *10* (Jan. 1967).

Janda, K., *Information Retrieval: Applications to Political Science* (The Bobbs-Merrill Co., Inc., New York, 1968).

continued

Tetzlaff, W.H., "TRIAL: Technique for Retrieving Information from Abstracts of Literature—A Program for the IBM 709/90/94," paper presented at the SHARE XXVI meeting, Appl. Management Sci. Proj. Committe, 24 Feb.–4 Mar. 1966, San Diego, Calif.

TRIAL: An Information Retrieval System for Creating, Maintaining, Indexing, and Retrieving from Files of Textual Information, User's Manual, Northwestern Univ. Vogelback Computing Ctr. (Oct. 1968; revised Dec. 1968).

USER INSTRUCTIONS

Because of the flexibility and variety of options available in the TRIAL system, it is recommended that those interested obtain the complete user's manual (with all format details) as cited in the reference below.

REFERENCES

TRIAL: An Information Retrieval System for Creating, Maintaining, Indexing, and Retrieving from Files of Textual Information, User's Manual, Northwestern Univ. Vogelback Computing Ctr. (Oct. 1968; revised Dec. 1968).

SAMPLE INPUT

```
VLORR,           ,CM67000,T2000,P42.   EDIT
ATTACH(TRIAL)
NOCOMP.
TRIAL.
*EDIT
NEW MASTER=1.
*DATA
*INSERT,ENTRY=1, INCREMENT=1.
ACM                                                       BOOKCC     011L0001
COLLECTED ALGORITHMS FROM CACM.=                          BOOKCC     012L0001
ASSOCIATION FOR COMPUTING MACHINERY,1966.                 BOOKCC     013L0001
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0001
40                                                                     4L0001
AFIPS                                                     BOOKCC     011L0002
PROCEEDINGS 1962 SPRING JOINT COMPUTER CONFERENCE.=       BOOKCC     012L0002
AFIPS, 1962.                                              BOOKCC     013L0002
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0002
10                                                                     4L0002
ALLEN D N DE G                                            BOOKCC     011L0003
RELAXATION METHODS.=                                      BOOKCC     012L0003
MC GRAW HILL, 1954.                                       BOOKCC     013L0003
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0003
50                                                                     4L0003
ASHBY R W                                                 BOOKCC     011L0004
DESIGN FOR A BRAIN.=                                      BOOKCC     012L0004
JOHN WILEY AND SONS, INC, 1960.                           BOOKCC     013L0004
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0004
33                                                                     4L0004
BAUMANN R            FELICIANO M          BAUER F L       BOOKCC     011L0005
INTRODUCTION TO ALGOL.=                                   BOOKCC     012L0005
PRENTICE HALL INC, 1964.                                  BOOKCC     013L0005
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0005
42                                                        BOOKCC     014L0005
    .                                                        .           .
    .                                                        .           .
    .                                                        .           .
RIORDAN J                                                 BOOKCC     011L0046
AN INTRODUCTION TO COMBINATORIAL ANALYSIS.=               BOOKCC     012L0046
WILEY AND SONS INC,1958.                                  BOOKCC     013L0046
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0046
55                                                        BOOKCC     014L0046
RULE W P                                                  BOOKCC     011L0047
INTRODUCTION TO FORTRAN PROGRAMMING.=                     BOOKCC     012L0047
PRINDLE WEBER AND SCHMIDT INC,1966.                       BOOKCC     013L0047
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0047
42                                                        BOOKCC     014L0047
SAKODA J M                                                BOOKCC     011L0048
DYSTAL MANUAL.=                                           BOOKCC     012L0048
BROWN UNIVERSITY, 1965.                                   BOOKCC     013L0048
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0048
42                                                        BOOKCC     014L0048
SATTERLY G T JR                                           BOOKCC     011L0049
SPACING OF INTERCHANGES AND GRADE SEPARATIONS ON URBAN    BOOKCC     012L0049
  FREEWAYS.=                                              BOOKCC     022L0049
                                                          BOOKCC     013L0049
  COMPUTING CENTER LIBRARY.                               BOOKCC     023L0049
323                                                       BOOKCC     014L0049
*END
```

continued

000 0034

```
*INDEX
*WORDS,TITL,CARDS(2),STATISTICS,
TRADITIONALLY,TWO-AND,UNSOLICITED,YOU,1,1-JUNE,109,-,-,14,2,27,27-28,3,30,31,4,
49,5,7,9,
ESTABLISHMENT,EXCERPTS,EXTENDING,IMPROVED,INTRODUCING,JULY,MOVE,OBVIOUS,
OFFICES,OUTLINE,PHY,QUARTERLY,RE,GRANT-THE,REPORT-JOINT,SATISFYING,SCHEME,SING,
SPIRIT,STEADY,STATUS,
ERROR,SERIAL,DESCRIPTION,GENERALIZED,SPECIAL,CASE,TIME,PUBLIC,ADVANCED,PERIOD,
FOURTH,BASES,INTRODUCTION,WRITING,SECOND,NATIONAL,PARTS,IDENTIFICATION,
COMPUTATIONAL,AT,PAPER,ACCOMPANY,STYLE,USE,VIA,NYC,ORIENTED,PROBLEMS,FUTURE,
TOOL,EFFECTS,SUBJECT,HUMAN,SOCIAL,NEW,PROVIDING,PATTERN,HANDBOOK,PERCEPTIONS,
ITS,JOR,OR,SIGNIFICANCE,DIFFERENCES,TOWARD,LIFE,JOINT,COMPOSITION,ALTERNATE,
SUPPORT,WORD,ASSOCIATED,SOLUTION,AS,COMPUTER,SELECTED,BASED,PART,SHOP,DIRECT,
FALL,PRELIMINARY,PAPERS,STATE,ENVIRONMENT,USED,MANUAL,FUNDAMENTALS,SIMPLE,
SEPTEMBER,CUMULATIVE,PANEL,SURVEY,IMPACT,RELATION,MODERN,DIAGNOSIS,TERMS,AID,
ISSUE,SERVICES,SEVEN-PLACE,CATALOG,MEASURES,SUPPLEMENT,OUTPUT,MATERIALS,FACT,
COURSE,COMMITTEE,PROJECTS,LOW-COST,PARTIAL,ATTITUDES,MECHANICAL,ANNOTATED,
REPRODUCIBLE,EXPERIMENTS,REPORT,FROM,USING,VERSUS,DECREASE,FLOW,FLEXIBLE,YOUR,
LIMITED,METHODOLOGY,DECISION,SCALE-ACCRA,EFFECT,DEVELOPMENT,ORGANIZATION,
EXAMPLE,FEATURE,ASSOCIATION,APPLIED,WITH,PROCEDURES,HANDLING,ANALYSIS,DOCUMENT,
OCTOBER,STUDY,BETWEEN,ORDINARY,RESEARCHERS,CAPACITY,ARGUMENT,IN,PLUS,NOTES,
GENERAL,OURS,CONTROLLED,AREA,APRIL,GUIDE,PERSONAL,LEAST,QUESTIONS,RELATEDNESS,
BASIS,VERSION,MARCH,CURRENT,FIRST,PRINCIPLES,MANAGING,TOTAL,INTERACTION,BASIC,
USER,LARGE,PROBLEM,PICTURE,PROCESSING,RESULTS,INDEX,DIGEST,SCHOOL,FIELDS,
CAPABILITY,THEIR,RESEARCH,CONSIDERATIONS,CONSTRUCTION,INTO,LONG,ELEMENTARY,
CONFERENCE,OF,POTENTIAL,VOLUME,STEP,FINAL,NEEDS,III,HOW,AUTOMATIC,INFERENCE,
PROJECT,TECHNIQUE,PARTY,INDIVIDUAL,LEARNING,THESIS,DEVICE,TECHNIQUES,GET,
UTILIZING,DATA,FOR,LABORATORY,OPERATIONS,HEURISTIC,SOCIETY,THINKING,REPORTS,KEY,
METHOD,JUNE,ILLUSTRATED,BULLETIN,LOOK,ORDER,TECHNICAL,OTHER,STAGES,WORKING,
EXCERPTS,IS,MULTIPLE,STANDARD,VALUES,REAL,PERFORMANCE,CERTAIN,CONTEXT,
LITERATURE,GENERATION,REFERENCE,SUMMARY,PHRASE,FACTS,ASPECTS,TEST,NO,II,
COLLECTED,COMMENT,ADVANCES,CONTROL,BRIEF,TREATMENT,COMPUTING,FINDING,
PUBLICATIONS,ACQUIRED,PREPARATION,ARISING,VOL,COMPARATIVE,PREPARED,DIRECTED,
ELEMENTS,PAST,ME,SERIES,ANALYTICAL,EXAMPLES,PURPOSE,RM,VARIABLES,AND,STUDIES,
STRATEGY,PHASE,DOCUMENTS,THROUGH,WITHIN,SOLVING,COMPUTERS,ROLES,PR,CENTER,
INSTRUCTOR,TOOLS,EDITION,DECEMBER,EXPERIMENTAL,LIBRARY,UP,SPECIFICATION,BY,
STRUCTURE,PRIMER,STRUCTURED,CHARACTER,RAPID,STRUCTURES,EXPERIMENT,BUSINESS,
SELECTION,TOPICS,LESS,METHODS,DETERMINE,LISTING,CONCEPTS,SELECTIVE,AIDED,ON,
PROGRESS,PROVING,CALCULATIONS,PRESENT,POSITIVE,IV,SMALL,RECOGNITION,ANALYSES,
ROLE,COMPARISON,APPROACH,REQUIREMENTS,SHARE,4TH,THIRD,USERS,INTRODUCTORY,
HIGHER,COMMUNICATION,CONVENTIONAL,CORRELATION,THREE,BASE,COLLEGE,INTERPRETATION,
APPLICATION,INFORMATION,MAKING,FIGURES,GROUP,INSTALLING,OBSERVATIONS,CAMPUS,
INVESTIGATION,GRADE,OPERATION,PRODUCTION,KIND,RESUME,AN,TESTS,TO,MACHINES,THE,
PERMUTED,FOUNDATIONS,EMPHASIS,TRAINING,AUTOMATED,INVESTIGATIONS,REVIEW,STEPS,
SOME,EASY,
A,B,C,D,E,F,G,H,I,J,K,L,M,N,O,P,Q,R,S,T,U,V,W,X,Y,Z.
*KWOC,TITL,CARDS(0,1,2,3,4).
*END
*PRINT
REFERENCE CODE, CARDS(1,2,3).
*END
*SEARCH
TEST SEARCH, 2,  ( COMPUTER = 100, )$
*END
*SEARCH
TEST 2, 3,
(
WILEY  .AND. 1960 = 100.
)$
*END
*SEARCH
TEST SEARCH LORR2, 2,  (
AMERICAN*POLITICAL*SCIENCE*REVIEW  .OR. POLITICAL  = 100,  )$
*END
```

SAMPLE OUTPUT

```
            THIS IS THE EDIT PHASE OF THE TRIAL SYSTEM
                      NEW MASTER IS ON........  1
                      REFERENCE CODE TYPE ....  1


   CONTROL CARD NOW BEING PROCESSED
                          *INSERT,ENTRY=1, INCREMENT=1.
                              BOOKCC      L0001                                       0       1 03/25/69
                              BOOKCC      L0002                                       0       2 03/25/69
                              BOOKCC      L0003                                       0       3 03/25/69
                              BOOKCC      L0004                                       0       4 03/25/69
                              BOOKCC      L0005                                       0       5 03/25/69
                              BOOKCC      L0006                                       0       6 03/25/69
                              BOOKCC      L0007                                       0       7 03/25/69
                              BOOKCC      L0008                                       0       8 03/25/69
                              BOOKCC      L0009                                       0       9 03/25/69
                              BOOKCC      L0010                                       0      10 03/25/69
                              BOOKCC      L0011                                       0      11 03/25/69
                              BOOKCC      L0012                                       0      12 03/25/69
                              BOOKCC      L0013                                       0      13 03/25/69
                              BOOKCC      L0014                                       0      14 03/25/69
                              BOOKCC      L0015                                       0      15 03/25/69
                              BOOKCC      L0016                                       0      16 03/25/69
                              BOOKCC      L0017                                       0      17 03/25/69
                              BOOKCC      L0018                                       0      18 03/25/69
                              BOOKCC      L0019                                       0      19 03/25/69
                              BOOKCC      L0020                                       0      20 03/25/69
                              BOOKCC      L0021                                       0      21 03/25/69
                              BOOKCC      L0022                                       0      22 03/25/69
                              BOOKCC      L0023                                       0      23 03/25/69
                              BOOKCC      L0024                                       0      24 03/25/69
                              BOOKCC      L0025                                       0      25 03/25/69
                              BOOKCC      L0026                                       0      26 03/25/69
                              BOOKCC      L0027                                       0      27 03/25/69
                              BOOKCC      L0028                                       0      28 03/25/69
                              BOOKCC      L0029                                       0      29 03/25/69
                              BOOKCC      L0030                                       0      30 03/25/69
                              BOOKCC      L0031                                       0      31 03/25/69
                              BOOKCC      L0032                                       0      32 03/25/69
                              BOOKCC      L0033                                       0      33 03/25/69
                              BOOKCC      L0035                                       0      34 03/25/69
                              BOOKCC      L0036                                       0      35 03/25/69
                              BOOKCC      L0037                                       0      36 03/25/69
                              BOOKCC      L0038                                       0      37 03/25/69
                              BOOKCC      L0039                                       0      38 03/25/69
                              BOOKCC      L0041                                       0      39 03/25/69
                              BOOKCC      L0042                                       0      40 03/25/69
                              BOOKCC      L0043                                       0      41 03/25/69
                              BOOKCC      L0044                                       0      42 03/25/69
                              BOOKCC      L0045                                       0      43 03/25/69
                              BOOKCC      L0046                                       0      44 03/25/69
                              BOOKCC      L0047                                       0      45 03/25/69
                              BOOKCC      L0048                                       0      46 03/25/69
                              BOOKCC      L0049                                       0      47 03/25/69


                  EDIT PROGRAM COMPLETED
                        47 ENTRIES ADDED TO MASTER FILE
                        47 ENTRIES NOW ON MASTER FILE


         EDIT EXECUTED FOR   1.150 SECONDS CENTRAL PROCESSOR TIME.
```

continued

```
------------------------------------------------

CONTROL CARD NOW BEING PROCESSED...

        *INDEX


------------------------------------------------



                THIS IS THE INDEX PHASE OF THE TRIAL SYSTEM

                           THE MASTER FILE IS ON UNIT          1

                          THE UNSORTED INDEX IS ON UNIT         2


        CONTROL CARD NOW BEING PROCESSED

                *WORDS,TITL,CARDS(2),STATISTICS.
THERE ARE  415 WORDS IN THE TABLE


        CONTROL CARD NOW BEING PROCESSED

                *KWOC,TITL,CARDS(0,1,2,3,4).



    THERE ARE       655  RECORDS ON THE TAPE TO BE SORTED
```

continued

```
THE FOLLOWING IS A LIST OF THE FREQUENCY OF WORDS OCCURING IN THE ENTRIES USING LIST      TITL

         1                                        1
         NATIONAL                                 0
         PROJECTS                                 0
         PUBLIC                                   0
         MATERIALS                                0
         ERROR                                    0
         SIMPLE                                   0
         ADVANCES                                 0
         SERIAL                                   0
         GENERALIZED                              0
         2                                        1
         SPECIAL                                  0
         STATUS                                   0
         0                                        0
         SCHEME                                   0
         PARTIAL                                  1
              .                                   .
              .                                   .
              .                                   .
         GRADE                                    1
         PROVING                                  0
         AS                                       0
         RESUME                                   0
         OUTLINE                                  0
         TESTS                                    0
         THIRD                                    0
         MACHINES                                 0
         PERMUTED                                 0
         REPORT-JOINT                             0
         EMPHASIS                                 0
         TRAINING                                 0
         OR                                       0
         AUTOMATED                                0
         REVIEW                                   1
         STEPS                                    0
         EASY                                     0


         INDEX EXECUTED FOR   2.210 SECONDS CENTRAL PROCESSOR TIME.

-----------------------------------------------

CONTROL CARD NOW BEING PROCESSED...

         *PRINT


-----------------------------------------------



          ENTER SORT

               SORTED TAPE =    3


         SORT EXECUTED FOR   5.986 SECONDS CENTRAL PROCESSOR TIME.


         ENTER PRINT
   REFERENCE CODE, CARDS(1,2,3).
```

continued

```
ALGOL                                              BOOKCC      L0005
   BAUMANN R             FELICIANO M                 BAUER F L
   INTRODUCTION TO ALGOL.=
   PRENTICE HALL INC, 1964.
     COMPUTING CENTER LIBRARY.

ALGORITHMIC                                        BOOKCC      L0033
   MARCOVITZ A B         SCHWEPPE E J
   AN INTRODUCTION TO ALGORITHMIC METHODS USING THE MAD
     LANGUAGE.=

     COMPUTING CENTER LIBRARY.

ALGORITHMS                                         BOOKCC      L0001
   ACM
   COLLECTED ALGORITHMS FROM CACM.=
   ASSOCIATION FOR COMPUTING MACHINERY,1966.
     COMPUTING CENTER LIBRARY.

AMERICAN                                           BOOKCC      L0026
   JANDA K
   CUMULATIVE INDEX TO THE AMERICAN POLITICAL SCIENCE REVIEW.=
   NORTHWESTERN UNIVERSITY PRESS,1964.
     COMPUTING CENTER LIBRARY.

APPROXIMATE                                        BOOKCC      L0028
   KANTOROVICH L V      KRYLOV V I
   APPROXIMATE METHODS OF HIGHER ANALYSIS.=
   P NOORDHOFF LTD,1958.
     COMPUTING CENTER LIBRARY.

APPROXIMATIONS                                     BOOKCC      L0022
   HASTINGS CECIL JR
   APPROXIMATIONS FOR DIGITAL COMPUTERS.=
   PRINCETON UNIVERSITY PRESS,1955.
     COMPUTING CENTER LIBRARY.

ARMY                                               BOOKCC      L0032
   LOVE A G              HELLMAN I L
   TABULATING EQUIPMENT AND ARMY MEDICAL STATISTICS.=
   U S ARMY MEDICAL SERVICE,1958.
     COMPUTING CENTER LIBRARY.

ART                                                BOOKCC      L0023
   HIGGINSON M V
   MANAGING WITH EDP - A LOOK AT THE STATE OF THE ART.
   AMERICAN MANAGEMENT ASSOCIATION INC, 1965.
     COMPUTING CENTER LIBRARY.

BARLOW                                             BOOKCC      L0011
   COMRIE L J
   BARLOW*S TABLES OF SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS
     AND RECIPROCALS.=
   CHEMICAL PUBLISHING CO INC, 1957.
     COMPUTING CENTER LIBRARY.

BIOMETRIC                                          BOOKCC      L0042
   RAO C RADHAKRISHNA
   ADVANCED STATISTICAL METHODS IN BIOMETRIC RESEARCH.=
   WILEY AND SONS INC,1952.
     COMPUTING CENTER LIBRARY.

BRAIN                                              BOOKCC      L0004
   ASHBY R W
   DESIGN FOR A BRAIN.=
   JOHN WILEY AND SONS, INC. 1960.
     COMPUTING CENTER LIBRARY.

CACM                                               BOOKCC      L0001
   ACM
   COLLECTED ALGORITHMS FROM CACM.=
   ASSOCIATION FOR COMPUTING MACHINERY,1966.
     COMPUTING CENTER LIBRARY.

CALCULUS                                           BOOKCC      L0045
   RICHARDSON M
   AN INTRODUCTION TO THE CALCULUS OF FINITE DIFFERENCES.=
   MACMILLAN CO,1950.
     COMPUTING CENTER LIBRARY.
```

.
.
.
.

continued

```
      PRINT EXECUTED FOR   3.174 SECONDS CENTRAL PROCESSOR TIME.




---------------------------------------------------

CONTROL CARD NOW BEING PROCESSED...

        *SEARCH


---------------------------------------------------




        ENTER THE SEARCH PHASE OF THE TRIAL SYSTEM


             TEST SEARCH, 2,  ( COMPUTER = 100, )$



        TEST SEARCH

    REFERENCE CODE............BOOKCC       L0002
    SERIAL NUMBER...........          2
    DATE OF ADDITION TO FILE 03/25/69
    DATE OF SEARCH........... 03/25/69

                AFIPS

                PROCEEDINGS 1962 SPRING JOINT COMPUTER CONFERENCE.

                AFIPS, 1962.
                  COMPUTING CENTER LIBRARY.

                10

                       THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                               WORDS           FREQUENCY
                               -----           ---------
                       COMPUTER                    1
```

continued

```
     TEST SEARCH

REFERENCE CODE...........BOOKCC       L0012
SERIAL NUMBER...........         12
DATE OF ADDITION TO FILE 03/25/69
DATE OF SEARCH........... 03/25/69

               CORBATO F J          PODUSKA J W          SALTZER J H

               ADVANCED COMPUTER PROGRAMMING.=

               MIT PRESS,1963.
                 COMPUTING CENTER LIBRARY.

               4


                      THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                              WORDS           FREQUENCY
                              -----           ---------
                      COMPUTER                        1




     TEST SEARCH

REFERENCE CODE...........BOOKCC       L0024
SERIAL NUMBER...........         24
DATE OF ADDITION TO FILE 03/25/69
DATE OF SEARCH........... 03/25/69

               HILSENRATH J

               OMNITAB A COMPUTER PROGRAM FOR STATISTICAL AND NUMERICAL
                 ANALYSIS.=


                 COMPUTING CENTER LIBRARY.

               422


                      THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                              WORDS           FREQUENCY
                              -----           ---------
                      COMPUTER                        1
```

continued

```
     TEST SEARCH

REFERENCE CODE...........BOOKCC      L0013
SERIAL NUMBER...........          13
DATE OF ADDITION TO FILE 03/25/69
DATE OF SEARCH.......... 03/25/69

             COULSON J E

             PROGRAMMED LEARNING AND COMPUTER BASED INSTRUCTION.=

             SYSTEM DEVELOPMENT CORPORATION.1962.
               COMPUTING CENTER LIBRARY.

             332

             THIS BOOK IS A REPORT OF THE PROCEEDINGS OF THE CONFERENCE
               ON APPLICATION OF DIGITAL COMPUTERS TO AUTOMATED
               INSTRUCTION. THE PAPERS ARE BASED ON RESEARCH AVAILABLE AT
               THAT TIME. THE TWELVE PAPERS IN PART I. THEORY AND
               EXPERIMENTATION IN PROGRAMMED LEARNING. WERE TO PROVIDE A
               FOUNDATION OF EMPIRICAL DATA AND THEORETICAL STRUCTURE
               CONCERNING AUTOMATED TEACHING AND PROGRAMMED LEARNING.
               SOME OF THE PAPERS ADD LITTLE TO THE FIELD. SOME REPORT ON
               INSIGNIFICANT STUDIES. WHILE OTHERS MAKE A DEFINITE
               CONTRIBUTION BY REPORTING ON SIGNIFICANT RESEARCH. PART II
               PART III. COMPUTER TECHNOLOGY IN AUTOMATED TEACHING.
               CONTAINS THREE PAPERS.

                    THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                          WORDS           FREQUENCY
                          -----           ---------
                    COMPUTER                      1


          4 HIT OUT OF       47 SEARCHED.


   SEARCH EXECUTED FOR    .698 SECONDS CENTRAL PROCESSOR TIME.
```

continued

```
-----------------------------------------------

CONTROL CARD NOW BEING PROCESSEC...

         *SEARCH


-----------------------------------------------



         FNTER THF SEARCH PHASE OF THE TRIAL SYSTEM


              TEST 2, 3,
              (
              WILEY  .AND. 1960 = 100,
              )$



          TEST 2


    REFERENCE CODE...........BOOKCC       L0004
    SERIAL NUMBER...........          4
    DATE OF ADDITION TO FILE 03/25/69
    DATE OF SEARCH.......... 03/25/69


                   ASHBY R W

                   DESIGN FOR A BRAIN.=

                   JOHN WILEY AND SONS, INC, 1960.
                     COMPUTING CENTER LIBRARY.

                   33

                          THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                                 WORDS           FREQUENCY
                                 -----           ---------
                          WILEY                          1
                          1960                           1




                 1 HIT OUT OF        47 SEARCHED.


          SEARCH EXECUTED FOR    .766 SECONDS CENTHAL PROCFSSOR TIMF.
```

continued

```
-----------------------------------------------

CONTROL CARD NOW BEING PROCESSED...

        *SEARCH


-----------------------------------------------




        ENTER THE SEARCH PHASE OF THE TRIAL SYSTEM


             TEST SEARCH LORR2, 2,  (
             AMERICAN*POLITICAL*SCIENCE*REVIEW  .OR. POLITICAL  = 100,  )$




        TEST SEARCH LORR2

    REFERENCE CODE...........BOOKCC      L0026
    SERIAL NUMBER...........         26
    DATE OF ADDITION TO FILE 03/25/69
    DATE OF SEARCH.......... 03/25/69

                JANDA K

                CUMULATIVE INDEX TO THE AMERICAN POLITICAL SCIENCE REVIEW.=

                NORTHWESTERN UNIVERSITY PRESS,1964.
                  COMPUTING CENTER LIBRARY.

                335

                        THE FOLLOWING WORDS WERE FOUND IN THE ENTRY

                                WORDS          FREQUENCY
                                -----          ---------
                        AMERICAN                   1
                        POLITICAL                  1
                        SCIENCE                    1
                        REVIEW                     1



              1 HIT OUT OF       47 SEARCHED.


        SEARCH EXECUTED FOR    .586 SECONDS CENTRAL PROCESSOR TIME.
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 14.812 seconds for central-processor time and 52.074 seconds for peripheral-processor time with a memory usage of 67,000 words.

Chargeable computer time was $3.58.

Charge to user = computer time + postage and handling + network overhead
= $3.58 + $15.00 + network overhead
= $18.58 + network overhead

CONTENTS—TRIAL

pages
1–3 Identification & Abstract
5 User Instructions
7–17 I/O
19 Cost—Contents

DESCRIPTIVE TITLE	Test Scorer and Statistical Analysis
CALLING NAME	TSSA NUCC072
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Richard Wolf and Leopold Klopfer The University of Chicago K. Jones Harvard University Graduate School of Education A. Gasche, B. Wright, and C. Bradford The University of Chicago
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

TSSA scores multiple-response tests that have a single correct response for each item, computes test and item statistics, computes the tetrachoric interitem correlation matrix, and performs a factor analysis and varimax rotation. The point-biserial correlation of each item with a criterion score also may be obtained. The number of alternative responses may vary from item to item.

Multiple-scoring keys may be used with the same set of data cards. This feature makes TSSA applicable for scoring and analysis of the Kuder preference record and similarly constructed multikeyed instruments. In addition, multiple jobs may be run.

Computational results include the following.

Individual Scores, including raw scores and scores corrected for guessing

continued

Item-Response Information, including the proportion of subjects selecting the correct response for each item (i.e., difficulty) and the proportion of subjects selecting each response

Test Statistics,[1] including the mean, standard deviation, skewness, and kurtosis (and their standard errors computed from formulas outlined by Fisher); test reliability (computed by Kuder-Richardson formula 20); a validity coefficient; and a Pearson product-moment correlation

Item-Analysis Information,[2,3] including the proportion of subjects passing an item, the item standard deviation, point-biserial correlations, reliability index, and validity index (computed from formulas given by Guilford and Gullicksen)

Tetrachoric Interitem Correlations[4]

Factor Analysis of Interitem Correlation Matrix,[5] with varimax rotation and plot

Multiple-Scoring Keys

A special feature of TSSA is the use of Multiple-Scoring Keys. Such a feature has two uses. (1) It allows a single set of responses to be scored in more than one way; practical application of this is the use of the program with data from an instrument such as the Kuder preference record where several scores, based on analyses of the same set of items, are desired. (2) A more common situation is the use of the program to obtain subtest scores and a total test score from one instrument. An application of this might be to score all the responses on a reading test and to obtain scores for reading speed, reading vocabulary, and level of comprehension, as well as a total reading score.

Multiple Jobs

The limitation of the procedures in the analyses of subtests is that only the raw scores for each individual or each subject will be meaningful. Corrected scores will *not* have any meaning. Thus, if an analysis excludes any items initially read, no corrected score will be printed. The reason for this is that the program treats *all* items excluded from analysis as incorrect responses. Thus, the use of a formula for correcting scores for guessing is fallacious in this instance. If the user desires meaningful corrected scores for subtests, he will have to reproduce his Data Cards and run multiple jobs, selecting for reading on any one job only those items for which analysis is desired, i.e., the subtest.

continued

The use of the Multiple-Jobs feature for scoring subtests yields meaningful corrected scores, as already mentioned. However, the advantage of the Multiple-Scoring-Key feature of the program is that the data need be read from cards only once. Subsequent reading of the data is done from binary tape (tape B3), thus achieving savings of time and, hence, cost.

The Multiple-Jobs feature may also be used for scoring and analyzing severly entirely different tests, with only a single loading of the program.

REFERENCES

1. Fisher, R.A., *Statistical Methods for Research Workers* (Oliver & Boyd, Edinburgh, 1954), 12th ed., pp. 70–75.

2. Guilford, J.P., *Psychometric Methods* (McGraw-Hill Book Co., Inc., New York, 1954), pp. 373–464.

3. Gullicksen, H., *Theory of Mental Tests* (John Wiley & Sons, Inc., New York, 1950), pp. 363–396.

4. Farrell, R.H., and Stern, G.G., "A Measure of Tetrachoric Association," presented at APA convention, Sept. 1951, Chicago (unpublished; a copy of this paper may be obtained by writing The University of Chicago Computing Center).

5. Wright, B.D., "120X120 Principle Components Analysis: Symmetric (with Varimax Rotation and Plot)," Univ. Chicago Soc. Sci. Div. Computer Library (1963; unpublished).

USER INSTRUCTIONS

Description of Input Data

Control Card

Parameter	*Columns*	*Contents*
M	1– 3	Number of items to be scored (≤120)
K	4	Number of alternative responses in each item (from 2 to 8). If this number varies from item to item, punch a 9 and prepare an Alternatives Card
NFM	5	Number of Variable-Format Cards (up to 9)
NKEY	6– 7	Number of scoring keys to be used with a single set of Response Cards (up to 99)

Variable-Format Card(s)

Parameter	*Columns*	*Contents*
FMT	1–72	Format governing the read format for the Key Card, Alternatives Card (if needed), Individual-Response Cards, and Finish Card

Note: Identification *must* come in Cols. 1–6 of the *first* card for an individual. Format for this is A6. Criterion score, if used, *must* come next, before any item response and *must* be in F format. Items may come in any arrangement on any number of cards. Up to 9 format cards may be used.

Name and Options Card

Parameter	*Columns*	*Contents*
AME	1–24	Name of test and/or group tested
MMM	25	Punched-output options 0: no punched output 1: punchout of scores and 1's and 0's for pass or not pass for each individual 2: punchout of scores and original responses to items for each individual 3: both options 1 and 2, above
MLM	26	Tetrachoric interitem correlations and factor-analysis option 0: no 1: yes

continued

KIV	27	Option for adjusting negative and corrected scores to zero 0: no 1: yes
ICRIT	28	Criterion score used. There is a builtin check for missing data; only complete data are used 0: no 1: yes
ICRS	29	Point-biserial correlation of items option 0: with raw scores 1: with corrected scores
IVAL	30	Correlation of criterion scores with— 0: raw scores 1: corrected scores (validity-coefficient option)
NF	31,32	Number of factors to be extracted (up to 10). Set at 5 if omitted; if NF>10, NF is set at 10

Key Card

Parameter	*Columns*	*Contents*
DKEY	1– 6	Leave blank or punch KEY
Y (I)	(variable)	Correct response for each item. (For use of multiple keys, see below)

Alternatives Card

Parameter	*Columns*	*Contents*
ALK	1– 6	Leave blank or punch ALTS
ALT (I)	(variable)	Number of alternatives for each item (from 2 to 8)

Note: The Alternatives Card, if needed, is laid out exactly like the Key Card of an Individual-Response Card, except that it contains the number of alternatives to each item rather that the responses themselves.

Individual-Response Card(s) (Same number of cards must be present for each individual and in the same order; Variable-Format Card specifies which columns will be read)

continued

Parameter	*Columns*	*Contents*
DENT	1– 6	Subject identification (numeric or alphabetic)
CRIT	(variable)	Criterion score (if used)
X (I)	(variable)	Response for each item

Finish Card [specified by Variable-Format Card(s)]

Parameter	*Columns*	*Contents*
DENT	1– 6	FINISH (signal that all data have been read from Response Cards)
	7–72	Blank

Note: Key Cards, Alternatives Cards, and Finish Cards always consist physically of the same number of cards and this number is identical to the number of cards for each Individual Response.

Multiple-Scoring Keys

To use Multiple-Scoring Keys with TSSA, several procedures must be followed. *First,* the responses to *all* the items must be read in at the initial reading of the data. *Second*, several scoring keys must be punched. If the first score sought is a total score, a Key Card with the correct answers to *all* items must be inserted in its specified place (see Key Card). If a subtest score is desired, a second Name and Options Card and a second Key Card must be included after the Finish Card(s) following the individual Data Cards. If a second subtest score is desired, another Name and Options Card and another Key Card must follow, etc. Therefore, for example, a test for which the total test and several subtests are to be scored and analyzed will include a Name and Options Card and Key Cards following the Finish Card(s) [with the Name and Options Card *preceding* the Key Card(s) in each set]. The number of scoring keys to be used is specified by the user in the Control Card (see Control Card).

As noted above, the responses to all the items must be read initially. To obtain subtest scores, the columns of a Key Card for those *items that are to be excluded* from a particular analysis *must be left blank*. Thus, if a test consists of 100 items and the first 50 are to be analyzed as a subtest, the columns on the subtest Key Card corresponding to the first 50 items on the test will contain the correct responses whereas the columns on the subtest Key Card corresponding to the remaining 50 items will *all* be left blank. In the same manner, any item may be excluded from a particular analysis by leaving blank the column corresponding to that item in a Key Card.

continued

Description of Output

Standard Printed Output

Individual Scores. For each individual: raw score, score corrected for guessing, number of item committed.

Item-Response Information. For each item: difficulty, proportion of subjects selecting each response, proportion of omits. Extremely easy ($p>0.95$) and extremely difficult ($p<0.05$) items are identified.

Test Statistics. For raw and corrected scores: test mean, standard deviation, skewness, kurtosis, standard error of each, and test of normality of the distribution. Test reliability by Kuder—Richardson formula 20. Validity coefficient—Pearson correlation between total test score and a criterion score (if a criterion score is used).

Item-Analysis Information. For each item: proportion passing, standard deviation, point-biserial correlation with criterion score (if present), reliability index, validity index (if there is a criterion score).

Optional Output

Tetrachoric Interitem Correlations

Factor Analysis of the Interitem Correlation Matrix

Obtains the largest principal components of the symmetric interitem correlation matrix and performs an orthogonal rotation of these components to the varimax criterion. The largest characteristic roots are presented in order of magnitude and the associated characteristic vectors are tabled and plotted.

Optional Punched Output

Score Cards for Each Individual

Contain subject identification, raw score, corrected score, number of items omitted, and either pass or fail for each item, or original response for each item, or both.

Limitations

Maximum number of scoring keys used	99
Maximum number of Variable-Format Cards	9
Maximum number of items	120
Maximum number of alternative responses for each item	8
Maximum number of factors to be extracted	10
Maximum number of individuals per job	99,999,999

continued

Job Deck Structure

```
  Job Card
  LIBRARY (TSSA)
  LGO.
  7-8-9 (EOR Card)
    Control Card
    Variable-Format Card(s)
    Name and Options Card                        ─┐
    Key Card(s)                                   │
    Alternatives Card(s)  (if called for by       │  may be
                           Control Card)          │  repeated for
    Data Deck—Individual-Response Cards           │  multiple jobs
    Finish Card(s)  (must follow last Data Card)  │
6-7-8-9 (EOI Card)                               ─┘
```

SAMPLE INPUT

```
VLORR,CH            CM63200.    TSSA
LIBRARY(TSSA)
GO.
0654
(A6,4X,65F1.0)
RUSSIAN PRE-TEST 1964
KEY       33423332212412431123142141433224324322124134443224432442113312111
CLARK     33423 3 212212431123412141122224  33143241131432244321 2  3
BACIANS   4242233221241241412441241233331434422142421344323443413333432
SHEARIN   334212322122324341224124 1323244333213324413143224432122134312431
BLUJ      33423332212432431221112131433244343314222133423223332132113312331
KOWALCZYK 43421334213232434122414131323214114313444113123234432132124341314
BULAK     13443432211132142 4311241143221414411
GEORGE    13421 31212312134122412131131 2   32242241332432 44321421313 2111
BARIJ     33423332213412434123112341433214344124424233443224432432113312111
SHABAN    33423332212412434121112141433234324312424133423321432442113312111
MISIUNAS  33421133212332434123242131133214224134124234443324232142133312111
IVANCEVICH32421 342134 24311134121313332243 4313122333443214432412
REPKA     4442144421432441112234333412122423124441234314122123321241
SKAPARS   334233321124424341222124423334244133221224332222144
RETDY     33221133113332134122411441243324341444132132223223342222213424424
MUSZAK    33423322213412431121112141433214324324124433413224432444113312111
COCHRANE   44213  2333421332243134233 2 444 13
FOREST    13421432231332414122342142321314144114424313123224432312343442121
TRESNAK   22421432212312134132312141323223134143324113443224434242123312234
SHAFER    23221123213342331121113233143134331444212332143221334224131442421
JACURA    13423332212412434121112321433244314314124223443324432122113312111
FINISH
```

SAMPLE OUTPUT

```
                                    INDIVIDUAL SCORES
SUBJECT IDENTIFICATION               RAW SCORE          CORRECTED SCORE          OMITS


       CLARK                             38                    33                  13
       BACIAN                            31                    21                   4
       SHEARI                            36                    27                   1
       BLUJ                              45                    38                   0
       KOWALC                            31                    20                   0
       BULAK                             17                    11                  29
       GEORGE                            37                    30                   7
       BABIJ                             53                    49                   0
       SHABAN                            55                    52                   0
       MISIUN                            46                    40                   0
       IVANCE                            37                    32                  12
       REPKA                             18                     5                   7
       SKAPAR                            31                    24                  14
       REIDY                             25                    12                   0
       MUSZAK                            55                    52                   0
       COCHRA                             9                     2                  35
       FOREST                            30                    18                   0
       TRESNA                            37                    28                   0
       SHAFER                            22                     8                   0
       JACURA                            49                    44                   0
```

continued

```
                                                   ITEM INFORMATION

 ITEM                                         PROPORTION OF     20 SUBJECTS SELECTING EACH RESPONSE

NUMBER    DIFFICULTY          OMIT        1          2          3          4          5          6          7          8


   1          .500            .050       .200       .100       .500       .150
   2          .750           0.000      0.000       .150       .750       .100
   3          .900           0.000      0.000       .100      0.000       .900
   4          .950           0.000      0.000       .950      0.000       .050
   5          .400           0.000       .550       .050       .400      0.000
   6          .450            .150       .150       .050       .450       .200
   7          .800            .050      0.000       .100       .800       .050
   8          .550            .100       .050       .550       .150       .150
   9          .900           0.000       .100       .900      0.000      0.000
   .           .               .
   .           .               .
   .           .               .
  51          .650            .100      0.000       .100       .150       .650
  52          .800            .150      0.000      0.000       .800       .050
  53          .650            .150      0.000       .650       .050       .150
  54          .200            .150       .400       .200       .050       .200
  55          .250            .200       .150       .200       .200       .250
  56          .700            .150      0.000       .700       .050       .100
  57          .550            .250       .550       .050       .100       .050
  58          .350            .250       .350       .100       .250       .050
  59          .500            .250       .100      0.000       .500       .150
  60          .550            .300      0.000      0.000       .550       .150
  61          .400            .350       .400       .100      0.000       .150
  62          .550            .350       .050       .550      0.000       .050
  63          .350            .350       .350       .050       .100       .150
  64          .350            .350       .350       .150       .150      0.000
  65          .500            .350       .500      0.000      0.000       .150
```

continued

```
            THE FOLLOWING ITEMS SHOULD BE ELIMINATED FROM THE TEST
                 BECAUSE OF EXTREME EASINESS OR DIFFICULTY

                        EASY ITEMS     DIFFICULT ITEMS

                                           44                                -


                                  TEST STATISTICS
     VARIABLE       MEAN    S.E.      ST. DEV.  S.E.      SKEWNESS  S.E.      KURTOSIS  S.E.     NO. OF SUBJECTS

     RAW SCORE      35.10   2.90      12.97     1.76        -.16    .51         -.53    .99            20
 CORRECTED SCORE    27.17   3.45      15.41     1.75         .06    .51         -.96    .99            20


                    SKEWNESS AND KURTOSIS SIGNIFICANT AT .05 LEVEL


                             TEST RELIABILITY =  .938
                            KUDER RICHARDSON FORMULA 20
```

continued

```
                                         ITEM ANALYSIS INFORMATION

                                                 POINT BISERIAL
                                                 CORRELATION OF
                                                   ITEM WITH
                PROPORTION          STANDARD                                           RELIABILITY     VALIDITY
     ITEM       ANSWERING          DEVIATION         TOTAL          CRITERION              INDEX          INDEX
    NUMBER         ITEM                OF             TEST            SCORE
               CORRECTLY              ITEM           SCORE

       1           .500               .500           .540            0.000                .270          0.000
       2           .750               .433           .387            0.000                .168          0.000
       3           .900               .300           .298            0.000                .089          0.000
       4           .950               .218           .320            0.000                .070          0.000
       5           .400               .490           .490            0.000                .240          0.000
       6           .450               .497           .334            0.000                .166          0.000
       7           .800               .400           .351            0.000                .140          0.000
       8           .550               .497           .410            0.000                .204          0.000
       9           .900               .300           .183            0.000                .055          0.000
       .             .                  .
       .             .                  .
       .             .                  .
      51           .650               .477           .515            0.000                .246          0.000
      52           .800               .400           .563            0.000                .225          0.000
      53           .650               .477           .652            0.000                .311          0.000
      54           .200               .400           .575            0.000                .230          0.000
      55           .250               .433           .485            0.000                .210          0.000
      56           .700               .458           .384            0.000                .176          0.000
      57           .550               .497           .619            0.000                .308          0.000
      58           .350               .477           .439            0.000                .209          0.000
      59           .500               .500           .632            0.000                .316          0.000
      60           .550               .497           .689            0.000                .343          0.000
      61           .400               .490           .749            0.000                .367          0.000
      62           .550               .497           .612            0.000                .304          0.000
      63           .350               .477           .641            0.000                .306          0.000
      64           .350               .477           .649            0.000                .310          0.000
      65           .500               .500           .594            0.000                .297          0.000
NCTE.  POINT BISERIAL CORRELATIONS OF ITEM WITH CRITERION SCORE AND
       VALIDITY INDEX ARE 0.0 BECAUSE OF ABSENCE OF CRITERION SCORE


               END OF TEST
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 1.936 seconds for central-processor time and 25.105 seconds for peripheral-processor time with a memory usage of 63,200 words. Chargeable computer time was $1.00 (Northwestern University minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—TSSA

pages

1–3 Identification & Abstract
5–9 User Instructions
11–15 I/O
17 Cost—Contents

DESCRIPTIVE TITLE	Zellner's Three-Stage Least-Squares Program
CALLING NAME	Z3SLS NUCC125
INSTALLATION NAME	Vogelback Computing Center Northwestern University
AUTHOR(S) AND AFFILIATION(S)	A. Zellner The University of Wisconsin L. Weiner Department of Industrial Engineering Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

Z3SLS computes two- and three-stage least-squares (2SLS and 3SLS) estimates of parameters in simultaneous or interdependent econometric models. The program first regresses each variable on all the predetermined variables within the model to yield unrestricted least-squares estimates of the reduced-form system. Coefficient estimates, standard errors, etc., are output of the first part of Z3SLS. The second set of computations yields either the 2SLS estimates or both 2SLS and 3SLS estimates, with associated statistics.

REFERENCES

Stroud, A., Zellner, A., and Chou, L.C., "Program for Computing Two- and Three-Stage Least Squares Estimates" (long writeup for Z3SLS), Northwestern Univ. Comp. Ctr. Available from EIN for the cost of duplication and mailing.

USER INSTRUCTIONS

Description of Input Data

Main-Problem Card

Columns	*Contents*
1– 2	Number of variables to be read from Data Cards
3– 5	Number of variables added by TRANS (see paragraph below)
6–10	Number of observations
11	Number of Format Cards
12–13	Number of equations in first set of computations (may equal 0)
14–15	Number of equations in second set (may not equal 0)
16	=1: correlation matrix for all variables in system is to be printed
17	=1: residual covariance matrix is to be printed =2: residual correlation matrix is to be printed =3: both matrices are to be printed
18	=1: only 2SLS (no 3SLS) estimates are to be printed
19	=1: covariance matrix of 3SLS estimates is to be printed =2: correlation matrix of 3SLS estimates is to be printed =3: both matrices are to be printed
20	=1: Durbin–Watson statistic for each equation of the second set is to be printed (used only if Cols. 12–13 equal 0) =2: as above, with residuals, punched one per card
21–22	Number of F statistics to be computed (see Sec. 2.3 of long writeup of Z3SLS[1])
23–24	Number of restricted estimates to be done (see Sec. 2.4 of long writeup of Z3SLS[1])
25	=0: covariance division option "0" is called =1: option "1" is called
26	=1: data from previous main problem are to be used. (No Variable-Name or Format Card may appear. The next card should be the first equation Control Card of second set. Columns 1–10 and 12–13 may be blank in this case.)

continued

Columns	*Contents*
27–80	Heading (to be printed at the top of each page)

Transformation Option: The data may be transformed as they are read in by hand-coding a subroutine that is called after each observation is read. The name and dimension statement are

```
SUBROUTINE TRANS (DATA, N)
DIMENSION DATA (70)
```

The vector, DATA, contains the Nth observation in positions 2 to (k+1), where k is the number of variables read in (see Cols. 1–2 of Main–Problem Card). The first position contains a 1.0 for the constant. Note that the vector is in double precision. If there is a change in the number of elements used in DATA, this must be noted in Cols. 3–5 of the Main–Problem Card. The number of variables added may be negative.

Variable-Name Card

Columns	*Contents*
3– 8	Name of variable having index number 1
9–10	Blank
11–16	Name of variable 2
17–18	Blank
⋮	⋮
73–74	Blank
75–80	Name of variable 10 [If more than 10 names are necessary, continue on another card in the same way. There must be one name (even if blank) for each variable. The total number of variables equals (Cols. 1–2) + (Cols. 3–5) + (Cols. 12–13). (Columns referred to are on the Main–Problem Card.)]

Format Card(s)

This is a standard FORTRAN Format Card that describes how the data are punched on the following Data Cards. (The word FORMAT is not punched and the format statement, including enclosing parentheses, may use all 80 columns on the card. The data must be read, one observation at a time, as floating-point numbers; thus only X, F, and E field specifications may be used.)

continued

Data Cards

The raw data for the full system only is read in with each observation grouped together on one or more cards. The values must correspond with the format specified on the Format Card.

Equation Control Card(s)

Columns	*Contents*
1– 6	Any alphanumeric identification to identify the equation
7–10	Blank
11	=1: covariance matrix of regression coefficients is to be printed =2: correlation matrix of coefficients is to be printed =3: both matrices are to be printed
12–16	Blank
17–18	Number of independent variables in this equation *Note:* If the constant term is to be included in the regression, it must be counted as an independent variable and must be included in the list of independent variables, starting in Col. 21. The constant term is designated by a variable number 0.
19–20	Number of the dependent variable (as it appears in the raw data)
21–22	Number of the 1st independent variable (see *Note* under Cols. 17–18 above)
23–24	Number of the 2nd independent variable
⋮	⋮
.	Etc. .

(A maximum of 30 independent variables is permitted.) The first set of computations provides M new variables ($Y_1, Y_2, \cdots, Y_M$). The number M is specified by Cols. 12–13 of the Main-Problem Card. These new variables are assigned index numbers in the order of computation, starting with [(Cols. 1,2) + (Cols. 3–5) + 1] and going up to [(Cols. 1,2) + (Cols. 3–5) + M]. The endogenous variables should be referred to by these index numbers when specifying the regressors in the second set of computations.

F-Statistic Control Cards

For each F statistic that is desired, the following cards must be included.

continued

(a) *First Card*

Columns	*Contents*
1– 2	Number of nonzero rows in the C matrix
3– 4	Number of cards described in (b) below
5–80	Any title for this F statistic

(b) *Cards Containing the Nonzero Elements of the C Matrix*

These elements are punched six per card as follows.

Columns	*Contents*
1– 8	Identification (or blank)
9–10	m_1 (punched in I format)
11–12	n_1
13–20	C_{m_1,n_1} (punched in F format)
⋮	⋮
69–70	m_6
71–72	n_6
73–80	C_{m_6,n_6}

Restricted-Information Control Cards

For each restriction computation desired, the R matrix and r vector (see Ref. 1, p. 9, Sec. 2.4) are punched on cards in exactly the form described above for the C matrix (see F-Statistic Control Cards). The r vector is assumed to be the (m + 1)st column of the kXm R matrix. (Here $k \leq m$, and m is the total number of independent variables in the analysis.)

Subroutines

Subroutine TRANS is provided with Z3SLS; however, hand coding of the subroutine is permissible [to allow user specification of a transformation (see p. 4)].

continued

Description of Output

1. Display of parameters from Main-Problem Card
2. Display of variable format
3. Means, standard deviation, and variance of the variables
4. Correlation coefficients of the variables
5. Stage 1 output:
    - (i) regression coefficient and standard deviation for each independent variable in each equation
    - (ii) inverse crossproduct matrix for variable appearing in each equation
    - (iii) normalized inverse matrix for each variable appearing in each equation
6. Stage 2 output:
    - (i) same as 5(i)–5(iii)
7. Stage 3 output:
    - (i) residual covariance matrix
    - (ii) residual correlation matrix
    - (iii) efficient estimates—coefficients and deviations for each variable appearing in each equation
    - (iv) coefficient covariance matrix
    - (v) coefficient correlation matrix
    - (vi) repeat 7(i)–7(v), with estimates subject to user's restrictions
8. Final message stating "normal termination"

Error Indications

An appropriate message is printed when parameters of the Main-Problem Card are beyond acceptable limits.

Limitations

The set of cards discussed under Description of Input Data may be repeated for as many sets of computations as desired. The capacity limits for this program are now the following.

continued

Total number of variables (including 1 for constant)	70
Number of equations in first set of calculations	20
Number of equations in second set of calculations	20
Number of independent variables in any equation	30
Number of restrictions tested by any F statistic	30
Number of restrictions imposed for estimation	30
Number of Format Cards	2

Job Deck Structure

```
Job Card
LIBRARY(Z3SLS)
LGO.
7-8-9 (EOR Card)
      Main-Problem Card
      Variable-Name Card(s)
      Format Card(s)
      Data Cards
      Equation Control Cards for 1st set
      Equation Control Cards for 2nd set
      F-Statistic Control Cards
      Restricted-Estimation Control Cards
6-7-8-9 (EOI Card)
```

REFERENCES

1. Stroud, A., Zellner, A., and Chou, L.C., "Program for Computing Two- and Three-Stage Least Squares Estimates" (long write-up for Z3SLS), Northwestern Univ. Comp. Ctr. Available from EIN for the cost of duplication and mailing.

SAMPLE INPUT

```
VLORR.CH[redacted]CM64400.     Z3SLS
LGO.
LIBRARY(Z3SLS)
13      211 3 31303     11 3SLS ON KLEIN DATA...DIVISOR NOT ADJUSTED
      W2          T          G     TIME    P(-1)    K(-1)   YTW2-1        C           I        W1
        P     W1+W2   Y+T-W2         PH     W1W2H    YTW2H
(3F12.5, F3.0, 3E12.5 / 6E12.5)
 0.27000E 01 0.77000E 01 0.69000E 01 1. 0.12700E 02 0.18280E 03 0.44900E 02   21A
 0.41900E 02-0.20000E-00 0.25500E 02 0.12400E 02 0.28200E 02 0.45600E 02      21B
 0.29000E 01 0.39000E 01 0.61000E 01 2. 0.12400E 02 0.18260E 03 0.45600E 02   22A
 0.45000E 02 0.19000E 01 0.29300E 02 0.16900E 02 0.32200E 02 0.50100E 02      22B
 0.29000E 01 0.47000E 01 0.57000E 01 3. 0.16900E 02 0.18450E 03 0.50100E 02   23A
 0.49200E 02 0.52000E 01 0.34100E 02 0.18400E 02 0.37000E 02 0.57200E 02      23B
 0.31000E 01 0.38000E 01 0.66000E 01 4. 0.18400E 02 0.18970E 03 0.57200E 02   24A
 0.50600E 02 0.30000E 01 0.33900E 02 0.19400E 02 0.37000E 02 0.57100E 02      24B
 0.32000E 01 0.55000E 01 0.65000E 01 5. 0.19400E 02 0.19270E 03 0.57100E 02   25A
 0.52600E 02 0.51000E 01 0.35400E 02 0.20100E 02 0.38600E 02 0.61000E 02      25B
 0.33000E 01 0.70000E 01 0.66000E 01 6. 0.20100E 02 0.19780E 03 0.61000E 02   26A
 0.55100E 02 0.56000E 01 0.37400E 02 0.19600E 02 0.40700E 02 0.64000E 02      26B
 0.36000E 01 0.67000E 01 0.76000E 01 7. 0.19600E 02 0.20340E 03 0.64000E 02   27A
 0.56200E 02 0.42000E 01 0.37900E 02 0.19800E 02 0.41500E 02 0.64400E 02      27B
 0.37000E 01 0.42000E 01 0.79000E 01 8. 0.19800E 02 0.20760E 03 0.64400E 02   28A
                          :           :           :           :

 0.67000E 01 0.67000E 01 0.11000E 0217. 0.17600E 02 0.19980E 03 0.62700E 02   37A
 0.58700E 02 0.20000E 01 0.41000E 02 0.17300E 02 0.47700E 02 0.65000E 02      37B
 0.77000E 01 0.74000E 01 0.13000E 0218. 0.17300E 02 0.20180E 03 0.65000E 02   38A
 0.57500E 02-0.19000E 01 0.38200E 02 0.15300E 02 0.45900E 02 0.60900E 02      38B
 0.78000E 01 0.89000E 01 0.14400E 0219. 0.15300E 02 0.19990E 03 0.60900E 02   39A
 0.61600E 02 0.13000E 01 0.41600E 02 0.19000E 02 0.49400E 02 0.69500E 02      39B
 0.80000E 01 0.96000E 01 0.15400E 0220. 0.19000E 02 0.20120E 03 0.69500E 02   40A
 0.65000E 02 0.33000E 01 0.45000E 02 0.21100E 02 0.53000E 02 0.75700E 02      40B
 0.85000E 01 0.11600E 02 0.22300E 0221. 0.21100E 02 0.20450E 03 0.75700E 02   41A
 0.69700E 02 0.49000E 01 0.53300E 02 0.23500E 02 0.61800E 02 0.88400E 02      41B
P        113      811 0 1 2 3 4 5 6 7
W1W2     113      812 0 1 2 3 4 5 6 7
YTW      113      813 0 1 2 3 4 5 6 7
C        113      4 8 0 51415
I        113      4 9 0 5 614
W1       113      410 0 4 716
 1 1   SUBJECT TO RESTRICTION THAT 1ST CONSTANT = 0.
          I 1  1.0
```

SAMPLE OUTPUT

```
NO. VARIABLES (IN DATA)     =  13
NO. VBLS. ADDED BY TRANS    =  -0
INSTRUMENTAL REGRESSIONS    =   3

TOTAL NO. OF VBLS.          =  16

NO. OF OBSERVATIONS       =    21

FORMAT ...         (3F12.5, F3.0, 3F12.5 / 6F12.5)


  VARIABLE           MEAN        STD. DEVIATION       VARIANCE


  1)        W2      5.11905E+00     1.90953E+00      3.64630E+00

  2)         T      6.80476E+00     1.98266E+00      3.93093E+00

  3)         G      9.91429E+00     3.81592E+00      1.45612E+01

  4)      TIME      1.10000E+01     6.05530E+00      3.66667E+01

  5)     P(-1)      1.63762E+01     3.93106E+00      1.54532E+01

  6)     K(-1)      2.00495E+02     9.67951E+00      9.36928E+01

  7)    YTW2-I      5.79857E+01     8.70365E+00      7.57536E+01

  8)         C      5.39952E+01     6.69552E+00      4.48300E+01

  9)         I      1.26667E+00     3.46635E+00      1.20156E+01

 10)        W1      3.63619E+01     6.15247E+00      3.78528E+01

 11)         P      1.68905E+01     4.11847E+00      1.69618E+01

 12)     W1+W2      4.14810E+01     7.37374E+00      5.43720E+01

 13)    Y+T-W2      6.00571E+01     1.03614E+01      1.07358E+02
```

continued

```
                                              CORRELATION COEFFICIENTS
      0           1           2           3           4           5           6           7           8           9
              0.          0.          0.          0.          0.          0.          0.          0.          0.              0
             10.000E-01  72.647E-02  87.835E-02  98.016E-02 -90.211E-03  33.477E-02  37.524E-02  64.375E-02 -23.285E-02     1
                         10.000E-01  81.420E-02  64.809E-02  50.848E-03  28.654E-02  41.495E-02  51.275E-02 -14.278E-02     2
                                     10.000E-01  86.906E-02  13.440E-02  36.489E-02  57.476E-02  73.037E-02 -73.909E-03     3
                                                 10.000E-01 -23.806E-03  47.983E-02  44.779E-02  67.852E-02 -23.957E-02     4
                                                             10.000E-01  15.421E-02  83.636E-02  65.205E-02  76.785E-02     5
                                                                         10.000E-01  47.577E-02  31.288E-02 -36.889E-02     6
                                                                                     10.000E-01  87.048E-02  45.569E-02     7
                                                                                                 10.000E-01  49.804E-02     8
                                                                                                             10.000E-01     9

                                                                             10          11          12          13
                                                                          0.          0.          0.          0.              0
                                                                         54.786E-02  32.599E-03  71.608E-02  47.728E-02     1
                                                                         46.652E-02 -47.348E-03  57.738E-02  44.954E-02     2
                                                                         71.378E-02  18.620E-02  82.302E-02  65.365E-02     3
                                                                         58.912E-02  36.089E-03  74.537E-02  49.774E-02     4
                                                                         72.233E-02  76.913E-02  57.933E-02  74.436E-02     5
                                                                         29.777E-02 -20.173E-02  33.515E-02  15.146E-02     6
                                                                         89.870E-02  61.495E-02  84.703E-02  85.747E-02     7
                                                                         97.797E-02  71.534E-02  98.270E-02  96.316E-02     8
                                                                         55.976E-02  92.334E-02  40.675E-02  67.207E-02     9
                                                                         10.000E-01  74.992E-02  97.625E-02  98.114E-02    10
                                                                                     10.000E-01  63.416E-02  83.372E-02    11
                                                                                                 10.000E-01  94.224E-02    12
                                                                                                             10.000E-01    13
```

continued

```
PROB. 1
STAGE 1

 EQ. ( 1)     P                         DF      13      SE2  2.9500E+00
 DEP VAR 11)        P
                                        R2   .8261      1-R2   .1739

       0) CONST.     1)     W2     2)       T      3)       G     4)   TIME      5)  P(-1)     6)  K(-1)      7) YTW2-1

 B     46.871E+00   -51.863E-02   -92.310E-02    43.902E-02    31.941E-02    80.250E-02   -21.610E-02    22.000E-03
 SD    18.757E+00    19.930E-01    34.128E-02    30.775E-02    61.223E-02    40.823E-02    93.718E-03    22.201E-02
B/SD   24.989E-01   -26.023E-02   -27.048E-01    14.265E-01    52.171E-02    19.658E-01   -23.059E-01    99.098E-03

                        INVERSE OF CROSS-PRODUCT MATRIX - P

                     0           1           2           3           4           5           6           7
            11.926E+01 -11.032E+00  43.538E-02 -12.315E-02  34.232E-01 -12.217E-01 -57.130E-02  55.901E-02       0
                        13.464E-01 -62.776E-03 -15.618E-03 -40.163E-02  10.875E-02  49.118E-03 -42.921E-03       1
                                    39.482E-03 -17.069E-03  19.662E-03 -54.674E-04 -25.762E-04  30.404E-04       2
                                                32.105E-03 -31.881E-04  14.979E-03  21.331E-04 -10.985E-03       3
                                                            12.706E-02 -26.984E-03 -15.176E-03  10.648E-03       4
                                                                        56.493E-03  81.466E-04 -29.455E-03       5
                                                                                    29.773E-04 -42.626E-04       6
                                                                                                16.707E-03       7

                        NORMALIZED INVERSE MATRIX -P

                     0           1           2           3           4           5           6           7
            10.000E-01 -87.063E-02  20.064E-02 -62.937E-03  87.939E-02 -47.067E-02 -95.874E-02  39.602E-02       0
                        10.000E-01 -27.228E-02 -75.121E-03 -97.103E-02  39.431E-02  77.579E-02 -28.617E-02       1
                                    10.000E-01 -47.944E-02  27.760E-02 -11.577E-02 -23.761E-02  11.838E-02       2
                                                10.000E-01 -49.916E-03  35.173E-02  21.818E-02 -47.430E-02       3
                                                            10.000E-01 -31.850E-02 -78.025E-02  23.112E-02       4
                                                                        10.000E-01  62.815E-02 -95.874E-02       5
                                                                                    10.000E-01 -60.439E-02       6
                                                                                                10.000E-01       7

                     :                 :                  :                 :
```

continued

```
PROB.  1
STAGE  2

    EQ. ( 1)     C                                    DF      17      SE2  1.0441E+00
    DEP VAR  8)       C

            0) CONST.      5)  P(-1)     14)     PH     15)  W1W2H

     B      16.555E+00     21.623E-02    17.302E-03     81.018E-02
    SD      13.208E-01     10.727E-02    11.805E-02     40.250E-03
  B/SD      12.534E+00     20.158E-01    14.657E-02     20.129E+00

                                           INVERSE OF CROSS-PRODUCT MATRIX - C

                                                                           0           5          14          15
                                                                   16.709E-01 -45.515E-04 -14.696E-03 -31.352E-03      0
                                                                               11.021E-03 -91.671E-04 -50.845E-05      5
                                                                                           13.348E-03 -14.616E-04     14
                                                                                                       15.517E-04     15


                                             NORMALIZED INVERSE MATRIX -C

                                                                           0           5          14          15
                                                                   10.000E-01 -33.541E-03 -98.409E-03 -61.573E-02      0
                                                                               10.000E-01 -75.583E-02 -12.295E-02      5
                                                                                           10.000E-01 -32.116E-02     14
                                       :            :            :            :                        10.000E-01     15
```

continued

```
PROB. 1
STAGE 3
                              RESIDUAL COVARIANCE MATRIX
                                                                         1            2            3
                                                                    10.441E-01   43.785E-02 -38.523E-02       1
                                                                                 13.832E-01   19.261E-02       2
                                                                                              47.643E-02       3

                              RESIDUAL CORRELATION MATRIX
                                                                         1            2            3
                                                                    10.000E-01   36.435E-02 -54.621E-02       1
                                                                                 10.000E-01   23.726E-02       2
                                                                                              10.000E-01       3
PROB. 1
STAGE 3


..... EFFICIENT ESTIMATES .....

OPTION 1 USED TO ESTIMATE COVARIANCES.


    EQ. ( 1)            DEP. VAL.     8)      C

          0) CONST.      5)  P(-1)    14)      PH     15)  W1W2H

   B     16.441E+00    16.314E-02   12.489E-02    79.008E-02
  SD     13.045E-01    10.044E-02   10.813E-02    37.938E-03
B/SD     12.603E+00    16.243E-01   11.550E-01    20.826E+00

    EQ. ( 2)            DEP. VAL.     9)      I

          0) CONST.      5)  P(-1)     6)  K(-1)    14)      PH

   B     28.178E+00    75.572E-02  -19.486E-02   -13.079E-03
  SD     67.934E-01    15.293E-02   32.531E-03    16.190E-02
B/SD     41.476E-01    49.415E-01  -59.897E-01   -80.787E-03

    EQ. ( 3)            DEP. VAL.    10)     W1

          0) CONST.      4)   TIME     7) YTW2-1    16)  YTW2H

   B     15.080E-02    14.967E-02   18.129E-02    40.049E-02
  SD     10.150E-01    27.935E-03   34.159E-03    31.813E-03
B/SD     14.858E-02    53.574E-01   53.073E-01    12.589E+00
                  .             .            .             .
                  .             .            .             .
                  .             .            .             .
```

continued

```
PROB.  1
STAGE  3

ESTIMATES SUBJECT TO                              SUBJECT TO RESTRICTION THAT 1ST CONSTANT = 0.

        1 RESTRICTION(S)...

 1     1.0000E+00  0.          0.          0.          0.          0.          0.          0.          0.          0.
       0.          0.          0.

                                                 RESIDUAL COVARIANCE MATRIX

                                                                                  1            2            3
                                                                          86.375E-01  -99.188E-03  -51.171E-02       1
                                                                                       13.832E-01   19.261E-02       2
                                                                                                    47.643E-02       3

                                                 RESIDUAL CORRELATION MATRIX

                                                                                  1            2            3
                                                                          10.000E-01  -28.696E-03  -25.225E-02       1
                                                                                       10.000E-01   23.726E-02       2
                                        ....       ....       ....       ....       ....           10.000E-01       3
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 5.056 seconds for central-processor time and 24.288 seconds for peripheral-processor time with a memory usage of 64,100 words. Chargeable computer time was $1.41.

Charge to user = computer time + postage and handling + network overhead
= $1.41 + $15.00 + network overhead
= $16.41 + network overhead

CONTENTS—Z3SLS

pages	
1	Identification & Abstract
3– 8	User Instructions
9–15	I/O
17	Cost–Contents

DESCRIPTIVE TITLE	Simulator of SAMOS (A Simple Imaginary Machine Language for Instruction)
CALLING NAME	SAMOS
INSTALLATION NAME	Computing Center, The Florida State University.
AUTHOR(S) AND AFFILIATION(S)	Marilyn Zupsich, Computing Center, The Florida State University
LANGUAGE	FORTRAN IV
COMPUTER	CDC 6400, 65K
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Marilyn Zupsich, Computing Center, The Florida State University, Tallahassee, Fla. 32306 Tel.: (904) 599-3418

FUNCTIONAL ABSTRACT

This program simulates the SAMOS computer described in the textbooks referred to below. The SAMOS programming language is a simplified machine-type language and is used to illustrate the logic of a computer to beginning-programming students. The simulator accepts programs written in the SAMOS language and executes them just as the mythical SAMOS computer would.

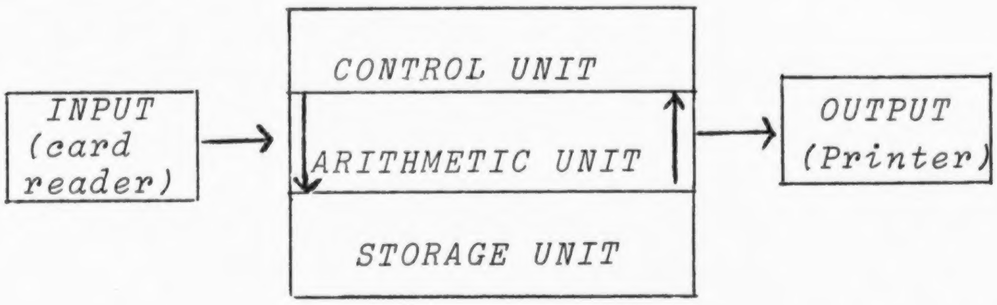
The SAMOS computer has 10,000 words of magnetic-core storage, each of which contains 10 characters and a sign (+ or -). Fifteen instruction types, covering arithmetic, branching, input, output, shifting, and the use of index registers, are simulated.

The basic design of the SAMOS computer is described in the following diagrams.

continued

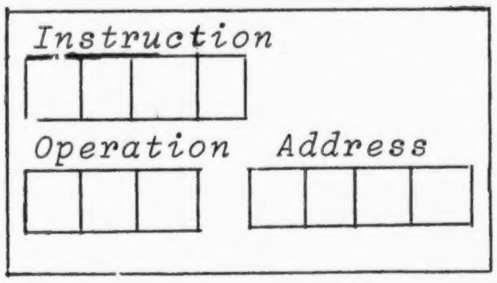
Description of SAMOS Computer

Basic Design

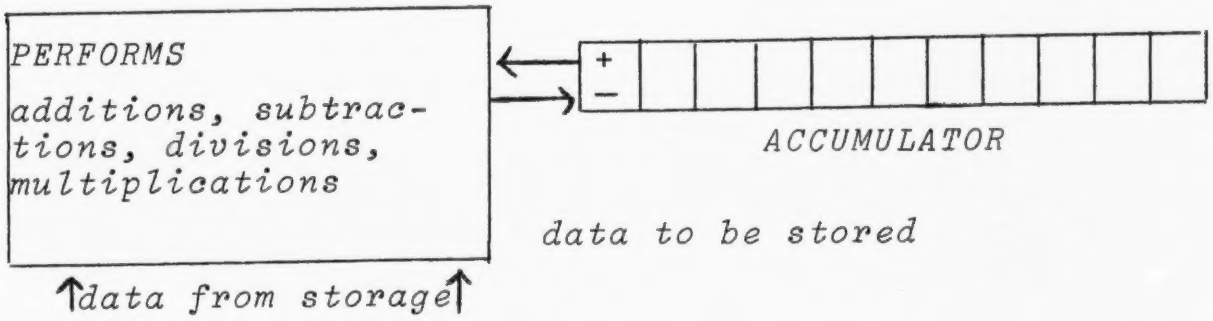

INPUT
(card
reader)
CONTROL UNIT
ARITHMETIC UNIT
STORAGE UNIT
OUTPUT
(Printer)

Control Unit

The control unit is the part of the computer that determines which instruction is to be done next, decodes the operation to be done, and coordinates machine working with the programmed instruction. To begin, the instruction counter is set to show where the program begins.


Instruction
Operation
Address

Arithmetic Unit


PERFORMS
additions, subtractions, divisions, multiplications
+
−
ACCUMULATOR
data to be stored
data from storage

REFERENCES

1. School Mathematics Study Group, *Algorithms, Computation and Mathematics* [A.C. Vroman, Inc. (367 S. Pasadena Ave.), Pasadena, Calif. 91105, 1966].

2. Forsythe, A., Keenan, T., Organick, E., and Stenberg, W., *Computer Science: A First Course* (John Wiley & Sons, Inc., New York, 1969).

3. Forsythe, A., Keenan, T., Organick, E., and Stenberg, W., *Computer Science: A Primer* (John Wiley & Sons, Inc., New York, 1969).

USER INSTRUCTIONS

Format of SAMOS Instructions

±	1	2	3	4	5	6	7	8	9	10

sign	the sign of an instruction must be +; if it is blank the sign is taken to mean +
1,2,3	characters in these positions indicate the operation to be performed (ADD, SUB, . . .)
4,5,6	either a 0 or 1 for index registers
7,8,9,10	memory address (0000 – 9999) or shift count for SHL, SHR instructions

Format to Type an Instruction on Card

Column	
1	sign
2– 4	operation code
5– 7	either a 1 or 0 for index registers
8–11	storage address or shift count
12–80	optional comments

Format of SAMOS Data

Column	
1	+, - or blank sign
2–11	any alphanumeric characters

SAMOS Instructions

Notation

aaaa	storage location
(aaaa)	contents of location aaaa
ACC	accumulator
←	is replaced by

Instructions

Load the accumulator

```
     +LDA000aaaa    (ACC) ← (aaaa)   (aaaa) remains unchanged
```

continued

Store the accumulator

+STO000aaaa (aaaa) ← (ACC) (ACC) remains unchanged

Add

+ADD000aaaa (ACC) ← (ACC) + (aaaa) (aaaa) unchanged

Subtract

+SUB000aaaa (ACC) ← (ACC) – (aaaa) (aaaa) unchanged

Multiply

+MPY000aaaa (ACC) ← (ACC) . (aaaa) (aaaa) unchanged

Divide

+DIV000aaaa (ACC) ← (ACC) / (aaaa) (aaaa) unchanged the remainder is lost (integer division)

Halt

+HLT000C000 stop execution

Branch unconditionally

+BRU000aaaa pick up next instruction at location aaaa; i.e., go to location aaaa and execute the instruction

Branch conditionally (branch on minus)

+BMI000aaaa if the sign of the ACC is negative (–), the next instruction to be executed is at location aaaa. If the sign of the accumulator is +, SAMOS will execute the next instruction in sequence

Overflow

ADD, SUB, MPY may cause overflow in the SAMOS computer. Division by zero also causes overflow. (Overflow means that the answer is too large to fit into one SAMOS word.) When overflow occurs, the error message **OVERFLOW and the instruction causing the overflow is printed out. Then the machine halts.

continued

Arithmetic errors

If SAMOS tries to execute any arithmetic statement when the accumulator or the storage address referenced does not contain solely numbers, **ARITHMETIC OPERATION ON ALPHANUMERIC INFORMATION is printed out. Also, the instruction causing this error and the area that contains the alphanumeric characters are printed out. Execution stops.

Input/Output Instructions

Read a word	+RWD000aaaa	one card is read; the information in Cols. 1-11 of that card is placed in storage location aaaa; the rest of the card is ignored
Write a word	+WWD000aaaa	the printer is advanced one line; the information in location aaaa is printed out *Note:* to print a blank line, store +bbbbbbbbbb (b denotes a blank column) in aaaa and then +WWD000aaaa

A program will stop when it runs out of cards. Running out of cards is a normal way to end a program. Other ways to end a program are with HLT or a statement at location aaaa which says +BRU000aaaa (it branches to itself).

Index registers

index register 1
index register 2
index register 3

4 cell registers

Load index n	+LIn000aaaa	load index register n (n=1,2, or 3) with the address part of (aaaa). [positions 7,8,9,10 of (aaaa)]

continued

Test index n	+TIn000aaaa	if index register n is zero, branch to location aaaa; otherwise subtract 1 from index register n; if index register n is not equal to zero, SAMOS concontinues with the next instruction in sequence

Remark: Columns 5, 6, 7 on an instruction card correspond to index registers 1, 2, and 3, respectively.

****if the column corresponding to an index register has a 1 in it, SAMOS will add the contents of the index register to the address part of the instruction before executing the instruction.

Shifting Instructions

Sometimes it is necessary to use part of a word or to combine several items into one word. This is done by instructions that move the accumulator to the left or right.

Shift left	+SHL000000n	this shifts the contents of the accumulator n positions to the left, where n is less than or equal to 9. The sign is unchanged. The leftmost n digits are lost and the rightmost n digits are zero
Shift right	+SHR000000n	this is similar to SHIFT Left, except that the contents of the accumulator are shifted n digits to the right.

Structure of a SAMOS Program Deck
(Items a, b, and d are required. Item c is optional.)

(a) SAMOS source deck
(b) A card that is all blank
(c) SAMOS data cards
(d) EOR card (7-8-9 card)

continued

Remarks

(a) Blanks other than a blank sign are not interpreted as zeros
(b) Several SAMOS program decks may be data to the simulator at one time. Each program will be processed separately and in sequence
(c) Before execution of each program, an 80-column listing of the source deck is produced, including the SAMOS core locations of each instruction
(d) Initially, the SAMOS memory, the accumulator, and the index registers are zero

Restrictions

The SAMOS source program must not exceed 10,000 storage words.

Error Messages

As a result of halts, overflows, and various errors, SAMOS prints out the contents of the index registers and of the accumulator. If processing was terminated by an error, an appropriate error message will be printed.

(a) **INCORRECT SIGN** character other than +, –, or blank in Col. 1.
(b) **INCORRECT OPERATION CODE**
(c) **NON-EXECUTABLE STATEMENT, LOCATION xxxx* may be the result of – in Col. 1.
(d) **OVERFLOW IN STORAGE ADDRESS xxxx**
(e) **ARITHMETIC OPERATION ON ALPHANUMERIC INFORMATION**
(f) **OVERFLOW** Arithmetic overflow
(g) **SHIFT ERROR**
(h) **NO BLANK CARD**
(i) **MORE THAN 10,000 CARDS**
(j) **OVERFLOW IN INDEX REGISTER** (number larger than 9999)

At The Florida State University, the SAMOS simulator is kept on a common file. To use the simulator, you need the following control cards.

1. Job card

Starting in Col. 1, type
job name (any name 1–7 characters long), CM45000,T10. job number, name

continued

job number is assigned by The Florida State University Computing Center for bookkeeping purposes.

Example: MZ, CM45000,T10. 0139, ZUPSICH

2. COMMON SAMOS. (starts in Col. 1)
3. SAMOS. (starts in Col. 1)
4. 7-8-9 card (a 7,8,9 multipunched in Col. 1)
5. SAMOS program decks as described above.

   You may run more than one program at a time since the simulator is a multiprocessor.
6. 6-7-8-9 card (a 6,7,8,9 multipunched in Col. 1)

SAMPLE INPUT

```
E,T3,CM43000, 0139, ZUPSICH
COMMON SAMOS.
SAMOS.
(7-8-9 CAHU)
 WWD0000013
 WWD0000014     WRITE FIRST TWO NUMHERS
 LDA0000014
 LI10000015    COUNT
 TI10000012
 ADD0000013
 STO0000013
 WWD0000013 WRITE THIRD AND ODD-NUMBERED NUM
 ADD0000014
 STO0000014
 WWD0000014    WRITE FOURTH AND EVEN-NO. NUM
 BRU0000004
 HLT0000000     THIS PROGRAM CALCULATES THE FIRST 50 FIBONACCI NUMBERS
 0000000001
 0000000001
 0000000050

(7-8-9 CARD)
(6-7-8-9 CARD)
```

SAMPLE OUTPUT

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$

     SAMOS EXECUTION

          0      WWD0000013
          1      WWD0000014     WRITE FIRST TWO NUMBERS
          2      LDA0000014
          3      LI10000015    COUNT
          4      TI10000012
          5      ADD0000013
          6      STO0000013
          7      WWD0000013 WRITE THIRD AND ODD=NUMBERFD NUM
          8      ADD0000014
          9      STO0000014
         10      WWD0000014    WRITE FOURTH AND EVEN=NO. NUM
         11      BRU0000004
         12      HLT0000000     THIS PROGRAM CALCULATES THE FIRST 50 FIBONACCI NUMBERS
         13      0000000001
         14      0000000001
         15      0000000050

                 0000000001
                 0000000001
                 0000000002
                 0000000003
                 0000000005
                 0000000008
                 0000000013
                 0000000021
                 0000000034
                 0000000055
                 0000000089
                 0000000144
                 0000000233
                 0000000377
                 0000000610
                 0000000987
                 0000001597
                 0000002584
                 0000004181
                 0000006765
                 0000010946
                 0000017711
                 0000028657
                 0000046368
                 0000075025
                 0000121393
                 0000196418
                 0000317811
                 0000514229
                 0000832040
                 0001346269
                 0002178309
                 0003524578
                 0005702887
                 0009227465
                 0014930352
                 0024157817
                 0039088169
                 0063245986
                 0102334155
                 0165580141
                 0267914296
                 0433494437
                 0701408733
                 1134903170
                 1836311903
                 2971215073
                 4807526976
                 7778742049
                **OVERFLOW**
                *END*
      INDEX REGISTER 1 =    26        INDEX REGISTER 2 =     0


      INDEX REGISTER 3 =     0        ACCUMULATOR =  7778742049
```

COST ESTIMATE

For the program listed in the Sample Input, the elapsed computer time was 2.075 seconds of central-processor time and 9.040 seconds of peripheral-processor time. The amount of memory required was on the order of $43,000_8$ words, thereby causing charges to be computed at the rate of $150./ computational unit (hour).

Approximate charge to user = computer time + consulting, handling, and postage + network overhead
= $0.46 + $7.50 + network overhead
= $7.96 + network overhead

CONTENTS—SAMOS

pages

1–3 Identification & Abstract
5–10 User Instructions
11,12 I/O
13 Cost—Contents

DESCRIPTIVE TITLE	O'Neill Concordance Package
CALLING NAMES	CONTEXT, CONCORD
INSTALLATION NAME	Computing Center The Florida State University
AUTHOR(S) AND AFFILIATION(S)	Julia C. Lawson Computing Center The Florida State University
LANGUAGE	CDC FORTRAN IV: Main Programs CDC Assembly Language (ASCENT): Subroutines
COMPUTER	CDC 6400: Concordance Preparation IBM 1401: Card-to-Tape Input and Sorting
PROGRAM AVAILABILITY	Program decks and documentation are presently available through the CDC users group (6400) Special cases will be considered by The Florida State University Computing Center Staff
CONTACT	Dr. E.P. Miles Jr., Director Computing Center, The Florida State University, Tallahassee, Fla. 32306 Tel.: (904) 599-3418

FUNCTIONAL ABSTRACT

The O'Neill Concordance Package has been developed to prepare a concordance to the plays of Eugene O'Neill. It consists of two related programs called CONTEXT and CONCORD.

CONTEXT operates on text that has been keypunched in a relatively free format on cards. The text is edited for spacing and for certain common keypunching errors and is broken into units called *contexts*, which are usually short complete sentences or substantial clauses or phrases ending with a comma or other punctuation. The contexts, which are the input for CONCORD, are then printed for visual inspection. Occasionally, a context will contain no punctuation or may be meaningless because of the mechanical rules used. For example, the abbreviation A.F. of L. will produce three separate contexts. Such occurrences may be corrected by preparing change data for the CONCORD program.

continued

CONCORD operates on the contexts produced earlier, updating these data according to changes resulting from a visual inspection. Words that are in a user-specified dictionary are then eliminated. Each remaining word is then written on magnetic tape with its associated context, location in the text, and serial numbers.

Finally, the words are sorted into alphabetic order and merged so that all contexts for a given word are grouped together. The resulting concordance is printed on standard continuous-form paper suitable for photographic reproduction.

USER INSTRUCTIONS—CONTEXT

Preparation of Text

Text is keypunched on IBM cards, with no attempt to complete a word (and no hyphenation) at the end of a card. Words must be separated by punctuation or at least one blank space. Because of limitations on characters available with keypunches, / is used for !, $ is used for ?, and * precedes and follows the name of a speaker. Similar sets of conventions will be necessary for other types of text. A logic table is used to adjust CONTEXT to other consistent sets of conventions.

The arrangement of the text on cards is controlled by a variable-input format specified on the input Control Card. The accompanying Sample Input uses a format that assigns the first 90 card columns to a line of text and defines three identification fields—one of four columns and two of six columns. Since an IBM card has only 80 columns, this format applies to each *pair* of Data Cards.

Logic Table

The logic table is a 15X15 matrix that determines which of 18 alternative actions is to apply to a given character. Let CC be the current character under consideration and let NC be the next following character. Then, the accompanying sample logic table selects among the following options.

Options

1. Do not enter CC into context line, continue to NC (e.g., the option might be used on a blank comma)
2. Move CC and continue (e.g., used on alpha—alpha)
3. Move CC into context line and suppress next move (e.g., used on a dash—blank)
4. Move CC and continue (option should be used when CC is a comma and NC is other than quotation marks, left parenthesis, alphanumeric, or asterisk)
5. Move CC and insert a blank before NC (e.g., upon encountering a comma—letter, one might wish to insert a space)
6. CC is a terminal character (e.g., period, right parenthesis, etc.) and NC is not an asterisk (denoting end of text). Enter CC and return. (If NC is a quotation mark, it will also be entered into the context line)
7. CC is a terminal character. Enter it into the context. NC is

continued

CONTEXT Sample Logic Table

B= blank N= numeric A= alpha O= other

CHARACTERS next current		B 1	= 2	- 3	+ 4	. 5	) 6	"(≠) 7	$ 8	* 9	, 10	(11	/ 12	N 13	A 14	O 15
blank	1	9	14	1	14	1	1	14	1	12	1	14	1	14	14	14
=	2	2	1	2	2	2	2	2	2	12	2	2	2	2	2	2
-	3	3	2	13	2	2	2	2	12	2	2	2	2	2	2	2
+	4	2	2	2	1	2	2	2	2	8	2	2	2	2	2	2
.	5	6	6	6	6	2	2	6	6	7	6	6	2	6	6	6
)	6	17	17	17	17	2	2	6	2	18	6	6	2	6	6	6
"(≠)	7	2	2	2	2	2	2	1	2	8	2	15	2	2	2	2
$	8	6	6	6	6	2	2	6	2	7	6	6	2	6	6	6
*	9	2	2	2	2	2	2	2	2	8	2	2	2	2	2	2
,	10	4	4	4	4	4	4	5	4	11	1	5	4	5	5	2
(	11	16	16	16	16	16	2	16	2	8	2	2	2	16	16	16
/	12	6	6	6	6	2	2	6	2	7	6	6	2	6	6	6
numeric	13	2	2	2	2	2	2	2	2	12	2	15	2	2	2	2
alpha	14	2	2	2	2	2	2	2	2	12	2	15	2	2	2	2
other	15	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10

continued

an asterisk. End the context line and return

8. NC is an asterisk. Move CC and test for * after NC. If so, then end context and return. If not, read a new line and continue
9. CC is a blank; NC is a blank. Move CC only if context line has begun. Otherwise, continue without move
10. CC is illegal. Print message to that effect
11. CC is a comma; NC is an asterisk. Move CC and go on as in Option 8
12. CC is a letter; NC is an asterisk. Move CC and go on as in Option 8
13. CC is a dash; NC is a dash. Move both and return (double dash is a terminal condition)
14. CC is a blank; NC is not a terminal character. Move CC and continue
15. CC is a letter; NC is a left parenthesis. Move CC and add a space before NC
16. CC is a left parenthesis. Move CC. If next character is a blank, suppress next move. Otherwise, continue
17. CC is a right parenthesis. If a left parenthesis has occurred in the context line and the line is sufficiently long, terminate and return. Otherwise, continue as in Option 6
18. CC is a right parenthesis; NC is an asterisk. Terminate the line as in Option 7

Control Cards

Title Card (required)

Columns	*Contents*
1–72	Alphanumeric information and/or numbers

Input Control Card

Columns	*Contents*
1– 3	"CCI"
4– 5	Block size of input (number records/block)
6– 7	Number machine words/record
8–10	Number characters/record

continued

Columns	*Contents*
11	Number of ID fields (6 characters each; maximum 5)
13–80	Variable-input format

Process Control Card

Columns	*Contents*
1– 3	"CCP"
4	Blank
5– 9	Serial ID of 1st record to be processed
10–14	Serial ID of last record to be processed
15	Blank
16–18	Length of text line
19–20	Minimum number of characters in a context-line serial number (i.e., which of the ID fields contains the serial ID to be used in comparing with the 1st and last records to be processed)

Output Control Card

Columns	*Contents*
1– 3	"CCO"
4– 5	Numbers of records/output block
6– 7	Number of machine words/records (maximum 2500)
13–80	Variable-output format

continued

USER INSTRUCTIONS—CONCORD

Logic Table

CONCORD uses a logic table that is a 15X15 matrix to decide the break points of a given unit of text—i.e., where words (speaking linguistically) begin and end. Let CC be the current character under consideration and let NC be the next following character. Then, the accompanying sample logic table selects among the following options.

Options

1. Space forward, continue scan
2. Two successive blanks (end of sentence)
3. Begin word
4. End word

Control Cards

Title Card (required)

Columns	*Contents*
1–72	Alphanumeric information and/or numbers

Input Control Card

Columns	*Contents*
1– 3	"CCI"
4– 5	Input block size (number of records/block)
6– 7	Number of machine words/record
8–10	Maximum number of characters/text line
11	Number of ID fields
13–80	Variable-input format of input record

Process Control Card

Columns	*Contents*
1– 3	"CCP"
4– 9	Starting-line number
10–15	Starting ID label

continued

CONCORD Sample Logic Table

B= blank N= numeric A= alpha O= other

CHARACTERS

next current		B 1	= 2	- 3	+ 4	. 5	) 6	"(≠) 7	$ 8	* 9	, 10	(11	/ 12	N 13	A 14	O 15
blank	1	2	1	1	1	1	1	3	1	1	1	1	1	3	3	1
=	2	1	1	1	1	1	1	3	1	1	1	1	1	3	3	1
-	3	1	1	1	1	1	1	3	1	1	1	1	1	3	3	1
+	4	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
.	5	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
)	6	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
"(≠)	7	4	4	4	1	4	4	1	4	4	4	4	4	1	1	1
$	8	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
*	9	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
,	10	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
(	11	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
/	12	1	1	1	1	1	1	1	1	1	1	1	1	3	3	1
numeric	13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
alpha.	14	4	4	4	1	4	4	1	4	4	4	4	4	1	1	1
other	15	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

continued

Columns	*Contents*
18–21	Ending-line number
22–27	Ending ID label
28	Position of label in ID fields
29	Position of serial in ID fields
30–50	Variable format for reading ID fields from Correction Cards. (If corrections are punched the same as text on tape, the variable format should be the same as the ID-fields portion of the input format)

Output Control Card

Columns	*Contents*
1– 3	"CCO"
4– 5	Number of logical records/physical record output
6– 7	Number of words/logical record output
13–72	Variable-output format

Label Card

Columns	*Contents*
1–10	Title to compare with starting label of text
11–16	
17	* if there is not a dictionary of deleted words to be read

Dictionary of Deleted Words

Columns	*Contents*
1–19 20–39 40–59 60–79	Punch four words/card, beginning in Cols. 1, 20, 40, and 60. End is signaled by *END.

Update Correction Cards

Columns	*Contents*
1	A: add to text R: replace line in text by correction P: replace flags by correction

continued

Job Deck Structure

Job Card
Library (CONTEXT, CONCORD)
LGO.

I. CONTEXT
- A. Control Card(s)
    - Title Card
    - Input Control Card
    - Process Control Card
    - Output Control Card
- B. Program Card(s)
- C. Data Card(s) or tape(s)
- D. EOF Card

II. CONCORD
- A. Control Card(s)
    - Title Card
    - Input Control Card
    - Process Control Card
    - Output Control Card
    - Label Card
    - Dictionary Card
    - Correction Card(s)
- B. Program Card(s)
- C. Data Card(s) or tape(s)
- D. EOF Card

SAMPLE INPUT—CONTEXT

```
THE BUNKS ON THE LEFT. A LAMP IN A BRACKET.  IN THE LEFT FOREGROUND. A           477 00010 CARDIF
DOORWAY.  ON THE FLOOR NEAR IT. A PAIL WITH A TIN DIPPER, OILSKINS ARE           477 00011 CARDIF
HANGING FROM A HOOK NEAR THE DOORWAY.                                            477 00012 CARDIF
THE FAR SIDE OF THE FORECASTLE IS SO NARROW THAT IT CONTAINS ONLY ONE SERIES     477 00013 CARDIF
OF BUNKS.                                                                        477 00014 CARDIF
IN UNDER THE BUNKS A GLIMPSE CAN BE HAD OF SEA-CHESTS. SUITCASES. SEA-BOOTS.     477 00015 CARDIF
ETC.. JAMMED IN INDISCRIMINATELY.                                                477 00016 CARDIF
AT REGULAR INTERVALS OF A MINUTE OR SO THE BLAST OF THE STEAMER#S WHISTLE        477 00017 CARDIF
CAN BE HEARD ABOVE ALL THE OTHER SOUNDS.                                         477 00018 CARDIF
FIVE MEN ARE SITTING ON THE BENCHES TALKING.  THEY ARE DRESSED IN DIRTY          477 00019 CARDIF
PATCHED SUITS OF DUNGAREE. FLANNEL SHIRTS. AND ALL ARE IN THEIR STOCKING         477 00020 CARDIF
FEET.  FOUR OF THE MEN ARE PULLING ON PIPES AND THE AIR IS HEAVY WITH RANCID     477 00021 CARDIF
TOBACCO SMOKE.  SITTING ON THE TOP BUNK IN THE LEFT FOREGROUND. A                477 00022 CARDIF
NORWEGIAN. PAUL. IS SOFTLY PLAYING SOME FOLK-SONG ON A BATTERED ACCORDION.       477 00023 CARDIF
HE STOPS FROM TIME TO TIME TO LISTEN TO THE CONVERSATION.                        477 00024 CARDIF
IN THE LOWER BUNK IN THE REAR A DARK-HAIRED. HARD-FEATURED MAN IS LYING          477 00025 CARDIF
APPARENTLY ASLEEP.  ONE OF HIS ARMS IS STRETCHED LIMPLY OVER THE SIDE OF         477 00026 CARDIF
THE BUNK.  HIS FACE IS VERY PALE. AND DROPS OF CLAMMY PERSPIRATION GLISTEN       477 00027 CARDIF
ON HIS FOREHEAD.                                                                 477 00028 CARDIF
(IT IS NEARING THE END OF THE DOG-WATCH--ABOUT TEN MINUTES TO EIGHT IN THE       478 00029 CARDIF
EVENING.)                                                                        478 00030 CARDIF
*COCKY* (A WEAZENED RUNT OF A MAN.  HE IS TELLING A STORY.  THE OTHERS ARE       478 00031 CARDIF
LISTENING WITH AMUSED. INCREDULOUS FACES. INTERRUPTING HIM AT THE END            478 00032 CARDIF
OF EACH SENTENCE WITH LOUD DERISIVE GUFFAWS) MAKIN# LOVE TO ME. SHE WAS.         478 00033 CARDIF
                                   .                            .                          .
                                   .                            .                          .
                                   .                            .                          .
DIVIL-MAY-CARE RAKE AV A MAN THE LOIKE AV COCKY$                                 478 00047 CARDIF
(A BURST OF LAUGHTER FROM THE CROWD)                                             478 00048 CARDIF
*COCKY* (INDIGNANTLY) GAWD STRIKE ME DEAD IF IT AIN#T TRUE. EVERY BLEEDIN#       478 00049 CARDIF
WORD OF IT.  #APPENED TEN YEAR AGO COME CHRISTMAS.                               478 00050 CARDIF
*SCOTTY* #TWAS A CHRISTMAS DINNER SHE HAD HER EYES ON.                           478 00051 CARDIF
*DAVIS* HE#D A BEEN A TOUGH OLD BIRD.                                            478 00052 CARDIF
*DRISCOLL* #TIS LUCKY FOR BOTH AV YE YE ESCAPE[illegible] FOR THE QUANE AV THE CANNIBAL  478 00053 CARDIF
ISLES WAD A DIED AV THE BELLYACHE THE DAY AFTHER CHRISTMAS. DIVIL                478 00054 CARDIF
A DOUBT AV IT. (THE LAUGHTER AT THIS IS LONG AND LOUD.)                          478 00055 CARDIF
*COCKY* (SULLENLY) BLARSTED FAT-#EADS/ (THE SICK MAN IN THE LOWER BUNK IN        478 00056 CARDIF
THE REAR GROANS AND MOVES RESTLESSLY.  THERE IS A HUSHED SILENCE.  ALL           478 00057 CARDIF
THE MEN TURN AND STARE AT HIM.)                                                  478 00058 CARDIF
*DRISCOLL* SSSHH/ (IN A HUSHED WHISPER) WE#D BEST NOT BE TALKIN# SO              478 00059 CARDIF
LOUD AND HIM TRYIN# TO HAVE A BIT AV A SLEEP.  (HE TIPTOES TO THE SIDE OF        479 00060 CARDIF
THE BUNK) YANK/ YOU#D BE WANTIN# A DRINK AV WATHER. MAYBE<                       479 00061 CARDIF
(YANK DOES NOT REPLY.  DRISCOLL BENDS OVER AND LOOKS AT HIM) IT#S ASLEEP         479 00062 CARDIF
HE IS. SURE ENOUGH.  HIS BREATH IS CHOKIN# IN HIS THROAT LOIKE WATHER GURGLIN#   479 00063 CARDIF
IN A POIPE. (HE COMES BACK QUIETLY AND SITS DOWN.  ALL ARE SILENT.               479 00064 CARDIF
AVOIDING EACH OTHER#S EYES.)                                                     479 00065 CARDIF
```

000 0038

SAMPLE OUTPUT—CONTEXT

```
THE MEN TURN AND STARE AT HIM.)                                              478   00058   CARDIF    10
SSSHH/                                                                       478   00059   CARDIF    20
(IN A HUSHED WHISPER)  WE#D BEST NOT BE TALKIN# SO   LOUD AND HIM TRYIN# TO HAVE   479   00060   CARDIF    30
A BIT AV A SLEEP.                                                            479   00060   CARDIF    40
(HE TIPTOES TO THE SIDE OF  THE BUNK)                                        479   00061   CARDIF    50
YANK/                                                                        479   00061   CARDIF    60
YOU#D BE WANTIN# A DRINK AV WATHER. MAYBE$                                   479   00061   CARDIF    70
(YANK DOES NOT REPLY.                                                        479   00062   CARDIF    80
DRISCOLL BENDS OVER AND LOOKS AT HIM)                                        479   00062   CARDIF    90
IT#S ASLEEP  HE IS. SURE ENOUGH.                                             479   00063   CARDIF   100
HIS BREATH IS CHOKIN# IN HIS THROAT LOIKE WATHER GURGLIN#  IN A POIPE.       479   00064   CARDIF   110
(HE COMES BACK QUIETLY AND SITS DOWN.                                        479   00064   CARDIF   120
ALL ARE SILENT.  AVOIDING EACH OTHER#S EYES.)                                479   00065   CARDIF   130
(AFTER A PAUSE)  PORE DEVIL/                                                 479   00066   CARDIF   140
IT#S OVER THE SIDE FOR #IM. GAWD #ELP  #IM.                                  479   00067   CARDIF   150
STOP YOUR CHOAKIN#/                                                          479   00068   CARDIF   160
HE#S NOT DEAD YET AND. PRAISE GOD. HE#LL  HAVE MANY A LONG DAY YET BEFORE HIM,   479   00069   CARDIF   170
(SHAKING HIS HEAD DOUBTFULLY)                                                479   00070   CARDIF   180
HE#S BOD. MON. HE#S VERRY BOD.                                               479   00070   CARDIF   190
LUCK, HE#S ALIVE.                                                            479   00071   CARDIF   200
MANY A MAN#S LIGHT WOULDA GONE OUT AFTER A FALL  LIKE THAT.                  479   00072   CARDIF   210
YOU SAW HIM FALL$                                                            479   00073   CARDIF   220
RIGHT NEXT TO HIM HE AND ME WAS GOIN# DOWN IN NUMBER TWO HOLD TO  DO SOME    479   00075   CARDIF   230
CHIPPIN#.                                                                    479   00075   CARDIF   240
HE PUTS HIS LEG OVER CARELESS-LIKE AND MISSES THE LADDER  AND PLUMPS STRAIGHT   479   00076   CARDIF   250
DOWN TO THE BOTTOM.                                                          479   00076   CARDIF   260
I WAS SCARED TO LOOK OVER  FOR A MINUTE.                                     479   00077   CARDIF   270
AND THEN I HEARD HIM GROAN AND I SCUTTLED DOWN AFTER HIM.                    479   00077   CARDIF   280
HE WAS HURT BAD INSIDE. FOR THE BLOOD WAS DRIPPIN# FROM THE SIDE OF HIS  MOUTH.   479   00079   CARDIF   290
HE WAS GROANIN# HARD. BUT HE NEVER LET A WORD OUT OF HIM.                    479   00079   CARDIF   300
 N# YOU BLOKES REMEMBER WHEN WE #AULED #IM IN #ERE$                          479   00080   CARDIF   310
 H. #ELL. #E SAYS. OH. #ELL--LIKE THAT. AND NOTHINK ELSE.                    479   00081   CARDIF   320
DID THE CAPTAIN KNOW WHERE HE ISS HURTED$                                    479   00082   CARDIF   330
THAT SILLY OL# JOSSER/                                                       479   00083   CARDIF   340
WOT THE #ELL WOULD #E KNOW ABAHT ANYTHINK$                                   479   00083   CARDIF   350
(SCORNFULLY)  HE FIDDLES IN HIS MOUTH WI# A BIT OF GLASS.                    479   00084   CARDIF   360
(ANGRILY)  THE DIVIL#S OWN LIFE UT IS TO BE OUT ON THE LONELY  SEA WID NOTHIN#   479   00086   CARDIF   370
BETUNE YOU AND A GRAVE IN THE OCEAN BUT A SPINDLE-SHANKED,                   479   00087   CARDIF   380
GRAY-WHISKERED AULD FOOL THE LOIKE AV HIM.                                   479   00087   CARDIF   390
#TWAS ENOUGH TO MAKE A SAINT  SHWEAR TO SEE HIM WID HIS GOLD WATCH IN HIS HAND.   479   00088   CARDIF   400
TRYIN# TO LOOK AS  WISE AS AN OWL ON A TREE.                                 480   00090   CARDIF   410
AND ALL THE TOIME HE NOT  KNOWIN# WHETHER #TWAS CHOLERY OR THE BARBER#S ITCH WAS   480   00090   CARDIF   420
THE MATTER WITH YANK.                                                        480   00090   CARDIF   430
(SARDONICALLY)  HE GAVE HIM A DOSE OF SALTS. NA DOUBT$                       480   00091   CARDIF   440
DIVIL A THING HE GAVE HIM AT ALL. BUT LOOKED IN THE BOOK HE HAD  WID HIM.    480   00093   CARDIF   450
AND SHOOK HIS HEAD. AND WALKED OUT WIDOUT SAYIN# A WORD.                     480   00094   CARDIF   460
THE  SECOND MATE AFTHER HIM NO WISER THAN HIMSELF.                           480   00095   CARDIF   470
GOD#S CURSE ON THE TWO AV  THIM/                                             480   00095   CARDIF   480
(AFTER A PAUSE)  YANK WAS A GOOD SHIPMATE. PORE BEGGAR.                      480   00096   CARDIF   490
LEND ME  FOUR BOB IN NOO YARK. #E DID.                                       480   00097   CARDIF   500
(WARMLY)  A GOOD SHIPMATE HE  AS AND IS. NONE BETTHER.                       480   00098   CARDIF   510
YE SAID  NO MORE THAN THE TRUTH. COCKY.                                      480   00099   CARDIF   520
FIVE YEARS AND MORE UT IS SINCE FIRST  I SHIPPED WID HIM.                    480   00100   CARDIF   530
AND WE#VE STUCK TOGETHER IVER SINCE THROUGH GOOD LUCK  AND BAD.              480   00101   CARDIF   540
FIGHTS. WE#VE HAD. GOD HELP US. BUT #TWAS ONLY WHEN WE#D A BIT  AV DRINK TAKEN.   480   00102   CARDIF   550
AND WE ALWAYS SHOOK HANDS THE NIXT MORNIN#.                                  480   00102   CARDIF   560
WHATIVER  WAS HIS WAS MINE.                                                  480   00103   CARDIF   570
AND MANY#S THE TOIME I#D A BEEN ON THE BEACH OR WORSE. BUT  FOR HIM.         480   00104   CARDIF   580
AND NOW--(HIS VOICE TREMBLES AS HE FIGHTS TO CONTROL HIS  EMOTION)           480   00105   CARDIF   590
DIVIL TAKE ME IF I#M NOT STARTIN# TO BLUBBER LOIKE AN AULD WOMAN.            480   00106   CARDIF   600
AND HE NOT DEAD AT ALL. BUT GOIN# TO LIVE MANY A LONG YEAR YET. MAYBE.       480   00106   CARDIF   610
THE SLEEP#LL DO HIM GOOD.                                                    480   00107   CARDIF   620
HE SEEMS BETTER NOW.                                                         480   00107   CARDIF   630
IF HE WUD EAT SOMETHING--                                                    480   00109   CARDIF   640
WUD YE HAVE HIM BE EATIN# IN HIS CONDISHUN$                                  480   00109   CARDIF   650
```

000 0038

000 0038

SAMPLE INPUT—CONCORD

```
CONCORDANCE RUN      TEST CONCORD


CCI 112 804 (1X,80R1,5X,3A10,I5)
CCP    10CARDIF  4000CARDIF44
CCO 113      (1H ,2A10,80R1,3A6,2I6)


BEGIN PROCESSING CARDIF
REDUNDANCY IN DICTIONARY OF WORDS TO BE DELETED           YOU≠VE

REDUNDANCY IN DICTIONARY OF WORDS TO BE DELETED           YOU≠VE

REDUNDANCY IN DICTIONARY OF WORDS TO BE DELETED           YOU≠VE

 DICTIONARY OF WORDS TO BE DELETED
         ABOUT
         ALL
         ALSO
         AM
         AND
         AN
         ARE
         AROUND
         AS
         AT
         AWAY
         BACKWARD
         BACK
         BAD
         BECAUSE
         BEEN
         BETWEEN
         BE
         BOY
         BOY≠S
         BUT
         BY
         CANNOT
         CAN
             .
             .
             .
         TO
         TWO
         UNDER
         UNTIL
         UPWARD
         UP
         US
         WAS
         WELL
         WEREN≠T
         WERE
         WE
         WHAT
         WHERE
         WHICH
         WHOSE
         WHO
         WILL
         WITH
         WOMAN
         WOMEN
         WOULD
         YES
         YOURSELF
         YOURS
         YOUR
         YOU
         YOU≠D
         YOU≠RE
         YOU≠VE
         YOU≠VE
         *END
```

SAMPLE OUTPUT—CONCORD

```
ALLEYWAY        (FROM THE ALLEYWAY)  GAWD BLIMEY, THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     1
GAWD            (FROM THE ALLEYWAY)  GAWD BLIMEY, THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     2
BLIMEY          (FROM THE ALLEYWAY)  GAWD BLIMEY, THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     3
FOG#S           (FROM THE ALLEYWAY)  GAWD BLIMEY  THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     4
THICK           (FROM THE ALLEYWAY)  GAWD BLIMEY, THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     5
SOUP            (FROM THE ALLEYWAY)  GAWD BLIMEY, THE FOG#S THICK AS SOUP.                 482   00181CARDIF    10     6
YE              ARE YE SATISFIED NOW, YANK$                                                482   00182CARDIF    20     7
SATISFIED       ARE YE SATISFIED NOW, YANK$                                                482   00182CARDIF    20     8
YANK            ARE YE SATISFIED NOW, YANK$                                                482   00182CARDIF    20     9
RECEIVING       (RECEIVING NO ANSWER, HE   BENDS OVER THE STILL FORM)                      483   00183CARDIF    30    10
ANSWER          (RECEIVING NO ANSWER, HE   BENDS OVER THE STILL FORM)                      483   00183CARDIF    30    11
FAINTED         HE#S FAINTED. GOD HELP HIM/                                                483   00183CARDIF    40    12
GOD             HE#S FAINTED. GOD HELP HIM/                                                483   00183CARDIF    40    13
HELP            HE#S FAINTED. GOD HELP HIM/                                                483   00183CARDIF    40    14
GETS            (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    15
TIN             (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    16
DIPPER          (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    17
BUCKET          (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    18
BATHES          (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    19
YANK#S          (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    20
FOREHEAD        (HE GETS A TIN  DIPPER FROM THE BUCKET AND BATHES YANK#S FOREHEAD WITH THE 483   00184CARDIF    50    21
WATER           WATER.                                                                     483   00184CARDIF    60    22
YANK            YANK  SHUDDERS AND OPENS HIS EYES.)                                        483   00185CARDIF    70    23
SHUDDERS        YANK  SHUDDERS AND OPENS HIS EYES.)                                        483   00185CARDIF    70    24
OPENS           YANK  SHUDDERS AND OPENS HIS EYES.)                                        483   00185CARDIF    70    25
EYES            YANK  SHUDDERS AND OPENS HIS EYES.)                                        483   00185CARDIF    70    26
SLOWLY          (SLOWLY)  I THOUGHT I WAS GOIN# THEN.                                      483   00186CARDIF    80    27
THOUGHT         (SLOWLY)  I THOUGHT I WAS GOIN# THEN.                                      483   00186CARDIF    80    28
GOIN#           (SLOWLY)  I THOUGHT I WAS GOIN# THEN.                                      483   00186CARDIF    80    29
WHA#            WHA# DID YUH WANTA WAKE ME UP  FUR$                                        483   00187CARDIF    90    30
YUH             WHA# DID YUH WANTA WAKE ME UP  FUR$                                        483   00187CARDIF    90    31
WANTA           WHA# DID YUH WANTA WAKE ME UP  FUR$                                        483   00187CARDIF    90    32
WAKE            WHA# DID YUH WANTA WAKE ME UP  FUR$                                        483   00187CARDIF    90    33
                                               .                                            .        .          .
                                               .                                            .        .          .
                                               .                                            .        .          .
IMPATIENTLY     (IMPATIENTLY)  BUT, MY GOOD MAN, I#M NOT A DOCTOR.                         485   00262CARDIF  1060   351
DOCTOR          (IMPATIENTLY)  BUT, MY GOOD MAN, I#M NOT A DOCTOR.                         485   00262CARDIF  1060   352
KINDLY          (MORE KINDLY  AS HE SEES DRISCOLL#S GRIEF)                                 485   00263CARDIF  1070   353
DRISCOLL#S      (MORE KINDLY  AS HE SEES DRISCOLL#S GRIEF)                                 485   00263CARDIF  1070   354
GRIEF           (MORE KINDLY  AS HE SEES DRISCOLL#S GRIEF)                                 485   00263CARDIF  1070   355
SHIPMATES       YOU AND HE HAVE BEEN SHIPMATES A LONG  TIME$                               485   00264CARDIF  1080   356
LONG            YOU AND HE HAVE BEEN SHIPMATES A LONG  TIME$                               485   00264CARDIF  1080   357
TIME            YOU AND HE HAVE BEEN SHIPMATES A LONG  TIME$                               485   00264CARDIF  1080   358
YEARS           FIVE YEARS AND MORE, SORR.                                                 485   00265CARDIF  1090   359
```

continued

CONCORDANCE OF 'THE ICEMAN COMETH' BY EUGENE O'NEILL

NUMBERS ON THE RIGHT SIDE OF THE CONCORDANCE REFER TO THE PAGE THAT
THE LINE OCCURS ON IN 'THE PLAYS OF EUGENE O'NEILL',
1954, NEW YORK, BY RANDOM HOUSE

```
AGO               (CONT'D.)                                                                  PAGE
    SOLD HIS SUIT AND SHOES AT SOLLY'S TWO DAYS AGO.                           581 ICEMAN
    HIS MOTHER AND I WERE FRIENDS YEARS AGO ON THE COAST.                      583 ICEMAN
    THAT WAS ELEVEN YEARS AGO.                                                 589 ICEMAN
    SINCE HIS WIFE DIED TWENTY YEARS AGO.                                      594 ICEMAN
    I MET DICK TRUMBULL ON THE STREET A YEAR OR TWO AGO.                       604 ICEMAN
    SAY, CHUCK'S KIDDIN' ABOUT DE ICEMAN A MINUTE AGO REMINDS ME.              617 ICEMAN
    WHY WOULDN'T YUH HOP OFF YOUR FIRE ESCAPE LONG AGO$                        666 ICEMAN
    WASN'T NONE OF THEM AROUND THE LAST TIME, TWENTY YEARS AGO.                687 ICEMAN
    HE KEPT HIMSELF LOCKED IN HIS ROOM UNTIL A WHILE AGO,                      700 ICEMAN
    AND THAT WAS YEARS AGO.                                                    707 ICEMAN
AGONY
    BUT TRYING NOT TO LISTEN, IN AN AGONY OF HORROR AND CRACKING NERVE.)       721 ICEMAN
AGREE
    (HE SINGS..) =OH, COME UP,= SHE CRIED, =MY SAILOR LAD, AND YOU AND I'LL AGREE,  597 ICEMAN
    (HE SINGS..) =OH, COME UP,= SHE CRIED, =MY SAILOR LAD, AND YOU AND I'LL AGREE.  607 ICEMAN
    (SHAKES HIS HEAD)  YOU'LL FIND HE WON'T AGREE TO THAT.                     642 ICEMAN
    AND THE BOORISH BOER HAD THE IMPERTINENCE TO AGREE WITH HIM.               650 ICEMAN
    =COME UP,= SHE CRIED, =MY ICEMAN LAD, AND YOU AND I'LL AGREE--=            662 ICEMAN
    DEY'D SAY, =SO YUH AGREE WID HICKEY, DO YUH, YUH DIRTY LITTLE GINNYS       669 ICEMAN
    WELL, WE AGREE WID HICKEY ABOUT YOU, SEE/                                  669 ICEMAN
AHEAD
    SO GO AHEAD AND SHOOT HIM.                                                 584 ICEMAN
    (HIS KIDDING A BIT FORCED)  YEAH, GO AHEAD, KID THE PANTS OFF US/          620 ICEMAN
    (HE IS STARING AHEAD OF HIM NOW                                            622 ICEMAN
    HE STARES AHEAD, DEEP IN HARRIED THOUGHT.                                  665 ICEMAN
    (HE CHUCKLES)  BUT THAT'S AHEAD OF MY STORY.                               710 ICEMAN
    THEY ARE ALL VERY DRUNK NOW, JUST A FEW DRINKS AHEAD OF THE PASSING-OUT STAGE,  727 ICEMAN
AIM
    BUT HIS AIM IS POOR AND IT LANDS ON HICKEY'S COAT.                         686 ICEMAN
AIR
    TELLING PEOPLE YOU THROW THE MONEY UP IN THE AIR                           582 ICEMAN
    YOU COMIN' UP FOR AIR$                                                     598 ICEMAN
    WITH A PATHETIC ATTEMPT AT A BRISK, NO-MORE-NONSENSE AIR) TOMORROW, YES.   600 ICEMAN
    PY GOTT, THERE IS SPACE TO BE FREE, THE AIR LIKE VINE IS,                  605 ICEMAN
    AND TOLD US ALL TO GIT DRESSED AND TAKE DE AIR/                            612 ICEMAN
    (WITH A BUSINESS-LIKE AIR)  I PICKED TWELVE BUCKS OFFA HIM.                617 ICEMAN
    (WITH AN AIR OF FRANKNESS)  YES, AND I OUGHT TO TAKE A WALK AROUND THE WARD.  626 ICEMAN
    PARRITT CHANGES TO A CONTRITE, APPEALING AIR)                              646 ICEMAN
    (HURRYING ON WITH AN ATTEMPT AT A PLAUSIBLE FRANK AIR                      648 ICEMAN
    (GIVES HUGO A SHAKE)  HEY, HUGO, COME UP FOR AIR/                          658 ICEMAN
    (HE HAS THE TERRIBLE GROTESQUE AIR, IN CONFESSING HIS SORDID BASENESS,     667 ICEMAN
    (AGAIN HE HAS A STRANGE AIR OF EXONERATING HIMSELF FROM GUILT              680 ICEMAN
```

continued

```
    COMING UP FOR AIRS                                                        691 ICEMAN
    WITH THE AIR OF A HOST WHOSE PARTY IS A HUGE SUCCESS, AND RAMBLES ON HAPPILY)  726 ICEMAN
    BEJEES, THIS AIN'T A FRESH-AIR CURE.                                      726 ICEMAN
AIRILY
    (IGNORES HIM--AIRILY)  YES, I'M LEAVING, ROCKY.                           675 ICEMAN
```

COST ESTIMATE

For the job listed on the Sample Input of CONTEXT, the total running time was 76.6 seconds for central-processor and peripheral-processor time at $2.50/hr. = $5.29.

For the job listed on the Sample Input of CONCORD, the total running time was 94.2 seconds for central-processor and peripheral-processor time at $2.50/hr. = $7.50.

Charge to user = computer time + postage and handling + network overhead
= $11.78 + $7.50 + network overhead
= $19.28 + network overhead

CONTENTS—CONTEXT, CONCORD

pages
1,2 Identification & Abstract
3–6 User Instructions—CONTEXT
7–9 User Instructions—CONCORD
10 Job Deck Structure—CONTEXT, CONCORD
11,12 I/O—CONTEXT
13–16 I/O—CONCORD
17 Cost—Contents

DESCRIPTIVE TITLE	Synagraphic Computer-Mapping Program
CALLING NAME	SYMAP 5.12
INSTALLATION NAME	Computing Center, The Florida State University
AUTHOR(S) AND AFFILIATION(S)	Howard T. Fisher, Northwestern Technological Institute (overall design and mathematical model) Mrs. O.G. Benson, Northwestern University Computing Center (programming)
LANGUAGE	FORTRAN IV
COMPUTER	Originally developed on IBM 709; also on IBM 360/40 and IBM 7094 at Harvard University Available in EIN through The Florida State University CDC 6400
PROGRAM AVAILABILITY	Decks, listings, and documentation presently available from The Florida State University Computing Center
CONTACT	Ray Soller, Librarian, Computing Center, The Florida State University, Tallahassee, Fla. 32306 Tel.: (904) 599-3418

FUNCTIONAL ABSTRACT

The Synagraphic Computer-Mapping Program (SYMAP) produces maps that depict spatially disposed quantitative and qualitative information. Raw data of every kind (physical, social, economic, etc.) may be related, weighted, and aggregated in a graphic format by assigning values to the coordinate locations of data points or data zones. According to the application and desired representation of data, three basic types of mapping procedure may be specified: contour, conformant, or proximal.

CONTOUR—based on the use of *contour* lines, each of which represents a value remaining constant throughout its length. The map consists of closed curves that connect all points having the same numerical

continued

value. The value at each of the different levels of contour (where a single contour level will represent a particular data value) is determined by the program, according to the scale of the map and the range of the data. Between any two contour lines, a continuous variation is assumed. Therefore, the use of contour mapping should be restricted to the representation of continuously varying information, such as topography, rainfall, or population density.

CONFORMANT—based on the *conformance* to the boundaries of a data zone. This type of mapping is best suited to data for which the representation as a continuously varying surface is inappropriate owing to the significance of physical limits or boundaries. Each predefined data zone is assigned one data value and, depending on its numeric class (range), one representative character on the map itself. Local variation within the zone boundaries will not be apparent, but will, on the average, be correct.

PROXIMAL—based on *proximity* to a data point. In appearance, this type of map is similar to the conformant map. However, point information is used here to define the data zones. Each character location on the output map is assigned the value of the *nearest* data point, using nearest-neighbor techniques. Boundaries are then assumed along the lines where these values change. Then the mapping is carried out as in the conformant type.

REFERENCES

Robertson, J. C., "The SYMAP Programme for Computer Mapping," Cartographic 108–113 (Dec. 1967); taken from a report of the Select Committee on the Ordinance Survey of Scotland.

Fisher, M., "The Laboratory for Computer Graphics," Harvard Univ. Grad. School Design Suppl. (Summer 1967).

Shepard, D., "A Two-Dimensional Interpolation Function for Irregularly Spaced Data," Harvard Univ. Grad. School Design Lab. Computer Graphics (Feb. 1968); available from the Computing Center, The Florida State University. Deals with the subject of analyzing irregularly spaced data derived from a continuous surface. A method is developed for reconstructing the surface from the sampled data. This method is the main device used to generate the maps produced by SYMAP.

USER INSTRUCTIONS

First, a user must establish the geographic area (called the *study area*) that he wishes to be mapped. This area may be rectangular or of any other desired shape, but it will be necessary to designate fixed borders from which required measurements (e.g., the relative positions of controlling points) and further lines of subdivision may be drawn. This "source map" orientation will be the device by which the input point coordinates (row and column) are determined, (As a reference guide, a standard character on the printer measures .1 X .125 in.)

The following is an example demonstrating the system control sequence required by the CDC 6400 when all input is by card.

```
SAMPLE,T60,CM72000.               job number, name
COMMON SYMAP.
REWIND(SYMAP)
SYMAP.
(7-8-9) punch in Col. 1           (EOR card)
    .
    .
    .
(data and program control cards)
    .
    .
    .
(6-7-8-9) punch in Col. 1         (EOF card)
```

Input to the computer is in the form of a deck of punched cards, consisting of the above introductory cards, followed by a number of "packages." The packages are each composed of additional cards describing some specific information about the desired map—e.g., boundary and data points, legends, barriers (permeable or impermeable), data values, title, etc.

User instructions are further documented in the reference cited below and are available as indicated.

REFERENCES

Reference Manual for Synographic Computer Mapping—"SYMAP," Harvard Univ. Grad. School Design Lab. Computer Graphics, Version V, Draft No. 2; available from the Computing Center, The Florida State University. Describes the three types of maps produced (contour, conformant, proximal) and contains detailed instructions on preparation of program control cards and organization of data for SYMAP.

SAMPLE INPUT

The order of the input cards in the data deck is not listed here explicitly but may be inferred from the format of the output that follows.

SAMPLE OUTPUT

```
SYMAP, VERSION 5

LABORATORY FOR COMPUTER GRAPHICS
DEPARTMENT OF CITY AND REGIONAL PLANNING
GRADUATE SCHOOL OF DESIGN
HARVARD UNIVERSITY
CAMBRIDGE, MASSACHUSETTS 02138
UNITED STATES OF AMERICA

TIME =  643.6

A-CONFORMOLINES
---------------


VERTEX           DOWN     ACROSS

    1    AREA

(    1)          1.02       3.32                                        E0465900
(    2)          1.79       3.66                                        E0466000
(    3)          3.56       3.04                                        E0466100
(    4)          3.57       2.86                                        E0466200
(    5)          3.55       2.57                                        E0466300
(    6)          2.63       1.31                                        E0466400
(    7)          2.33       1.50                                        E0466500
(    8)          1.71       1.50                                        E0466600
(    9)          1.29       2.02                                        E0466700
(   10)          1.03       2.86                                        E0466800
(   11)          1.02       3.32                                        E0466900
LENGTH=       7.73
AREA=      4.05
CENTER=(      2.22,       2.56)

    2    AREA

(    1)          2.12       6.32                                        E0467000
(    2)          1.79       3.66                                        E0467100
(    3)          1.02       3.32                                        E0467200
(    4)          0.70       4.17                                        E0467300
(    5)          0.68       5.84                                        E0467400
(    6)          0.85       6.32                                        E0467500
(    7)          2.12       6.32                                        E0467600
LENGTH=       7.88
AREA=      3.43
CENTER=(      1.34,       4.99)

    3    AREA

(    1)          2.12       6.32                                        E0467700
(    2)          2.64       6.01                                        E0467800
(    3)          3.63       5.43                                        E0467900
(    4)          1.79       3.66                                        E0468000
(    5)          2.12       6.32                                        E0468100
LENGTH=       6.99
AREA=      2.15
CENTER=(      2.51,       5.14)
              .                                                            .

              .                                                            .

              .                                                            .

   14    AREA

(    1)          5.70       4.14                                        E0477200
(    2)          6.55       4.39                                        E0477300
(    3)          6.56       4.04                                        E0477400
(    4)          7.18       3.21                                        E0477500
(    5)          7.17       2.66                                        E0477600
(    6)          5.67       1.60                                        E0477700
(    7)          5.29       1.58                                        E0477800
(    8)          4.62       2.45                                        E0477900
(    9)          5.70       4.14                                        E0478000
LENGTH=       8.14
AREA=      4.29
CENTER=(      5.95,       2.92)

   15    AREA

(    1)          3.57       2.86                                        E0478100
(    2)          4.62       2.45                                        E0478200
(    3)          5.29       1.58                                        E0478300
(    4)          5.30       1.42                                        E0478400
(    5)          3.89       0.41                                        E0478500
(    6)          3.27       0.41                                        E0478600
(    7)          2.60       1.20                                        E0478700
(    8)          2.63       1.31                                        E0478800
(    9)          3.55       2.57                                        E0478900
(   10)          3.57       2.86                                        E0479000
LENGTH=       7.74
AREA=      3.95
CENTER=(      3.92,       1.53)
```

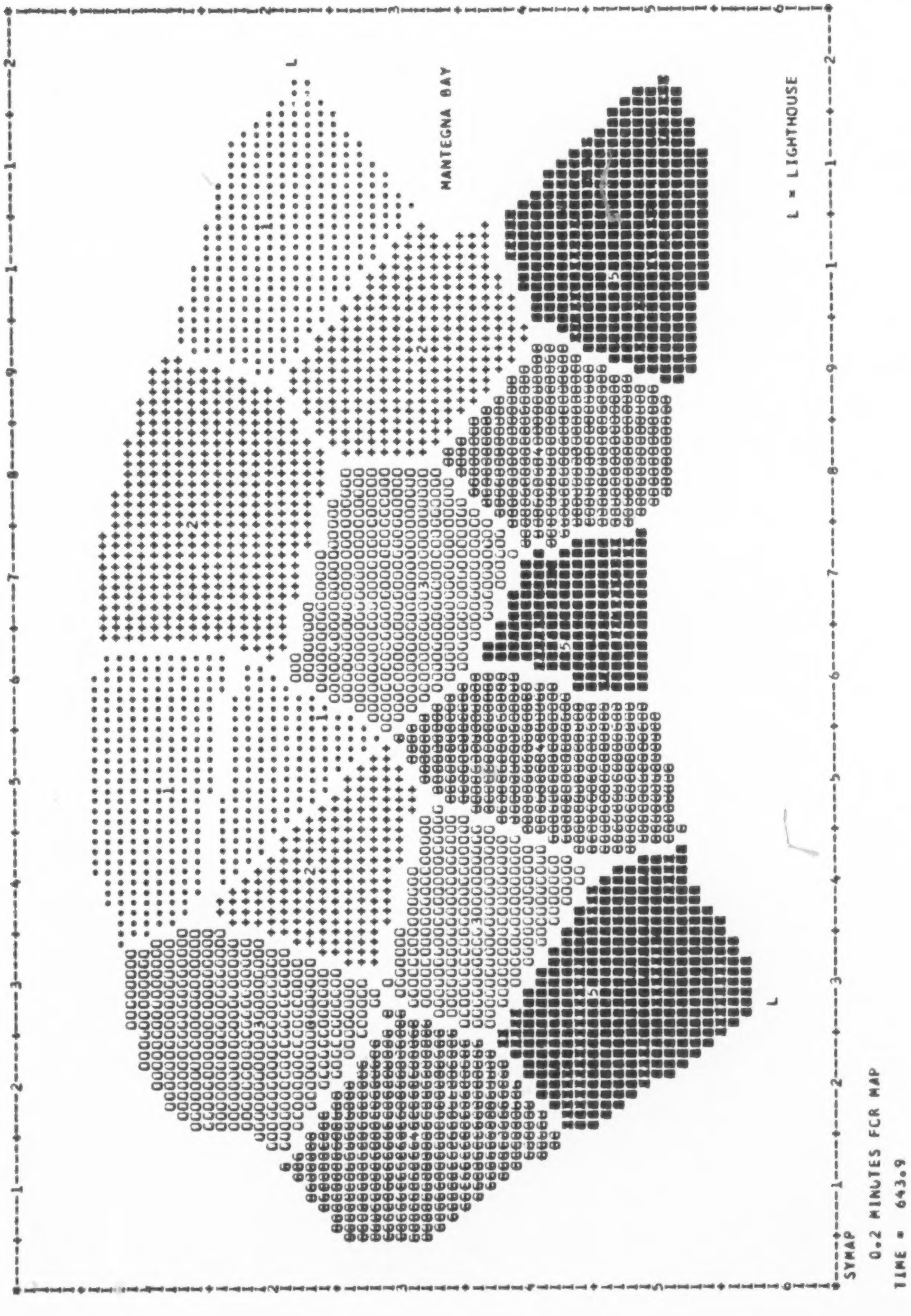
continued

```
B-DATA POINTS
-------------

POINT              DOWN    ACROSS

(    1)            2.34      2.56                                                   E0479300
(    2)            1.50      4.85                                                   E0479400
(    3)            3.00      5.56                                                   E0479500
(    4)            1.75      7.52                                                   E0479600
(    5)            2.53     10.44                                                   E0479700
(    6)            2.87      4.06                                                   E0479800
(    7)            4.01      6.91                                                   E0479900
(    8)            4.00      9.21                                                   E0480000
(    9)            5.89      9.94                                                   E0480100
(   10)            5.09      8.23                                                   E0480200
(   11)            5.37      6.34                                                   E0480300
(   12)            5.16      5.33                                                   E0480400
(   13)            4.51      3.64                                                   E0480500
(   14)            5.67      2.90                                                   E0480600
(   15)            3.88      1.54                                                   E0480700


C-GTGLEGENDS
------------

VERTEX             DOWN    ACROSS      +ROWS      +COLS

(    1) 'L' AT POINT

                   2.75     12.00        -0.        -0.                         E0481000
(    2) 'MANTEGNA BAY' ACROSS FROM
                   4.25     10.80        -0.        -0.                         E0481100

(    3) 'L' AT POINT

                   7.36      2.80        -0.        -0.                         E0481300
(    4) 'L = LIGHTHOUSE' ACROSS FROM
                   7.63     10.50        -0.        -0.                         E0481400


E-VALUES
--------

DATUM             VALUE

(    1)           62.28                                                         E0481800
(    2)           18.89                                                         E0481900
(    3)           -0.00                                                         E0482000
(    4)           47.65                                                         E0482100
(    5)            6.07                                                         E0482200
(    6)           38.73                                                         E0482300
(    7)           67.62                                                         E0482400
(    8)           45.26                                                         E0482500
(    9)           98.41                                                         E0482600
(   10)           73.06                                                         E0482700
(   11)           81.17                                                         E0482800
(   12)           79.09                                                         E0482900
(   13)           59.17                                                         E0483000
(   14)           85.53                                                         E0483100
(   15)           73.67                                                         E0483200
```

continued

```
F-MAP
-----

C    CONFORMANT MAP


C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT

ELECTIVE

    1 MAP SIZE IS            8.00 INCHES LONG BY         12.50 INCHES WIDE
    2 EXTREME POINTS ARE (      0.00,      0.00) AND (       8.00,      12.50)
    5 UPPER DATA LIMIT IS    100.00
    6 SAME NUMBER OF DATA POINTS IN EACH LEVEL
   10 MAP TEXT
                           DATA POINTS REPRESENT LOCATIONS OF PLANTATIONS USED FOR SAMPLING
   25 PRINT DATA POINT SYMBOLS

   0.1 MINUTES FOR INPUT

TIME =  643.7

MAP   1
-------

C    CONFORMANT MAP

C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT



MAP SCALE =      1.0000 INCHES ON OUTPUT MAP/UNITS ON SOURCE MAP

MAP SHOULD BE PRINTED AT   8.0 ROWS PER INCH AND  10.0 COLUMNS PER INCH

ROW    = DOWN   COORDINATE *     8.0000
COLUMN = ACROSS COORDINATE *    10.0000


CONFORMOLINES FOR MAP

 ZONE      TYPE        ROW     COLUMN      DATUM      VALUE      LEVEL

    1)       A          18        25          1       62.28        3
    2)       A          11        48          2       18.89        1
    3)       A          22        50          3       -0.00        1
    4)       A          16        76          4       47.65        2
    5)       A          22       104          5        6.07        1
    6)       A          23        42          6       38.73        2
    7)       A          31        68          7       67.62        3
    8)       A          31        93          8       45.26        2
    9)       A          47       103          9       98.41        5
   10)       A          42        83         10       73.06        4
   11)       A          43        67         11       81.17        5
   12)       A          41        51         12       79.09        4
   13)       A          37        37         13       59.17        3
   14)       A          47        30         14       85.53        5
   15)       A          32        16         15       73.67        4

TIME =  643.7
```

continued


MANTEGNA BAY
L = LIGHTHOUSE
L
SYMAP
0.2 MINUTES FCR MAP
TIME = 643.9

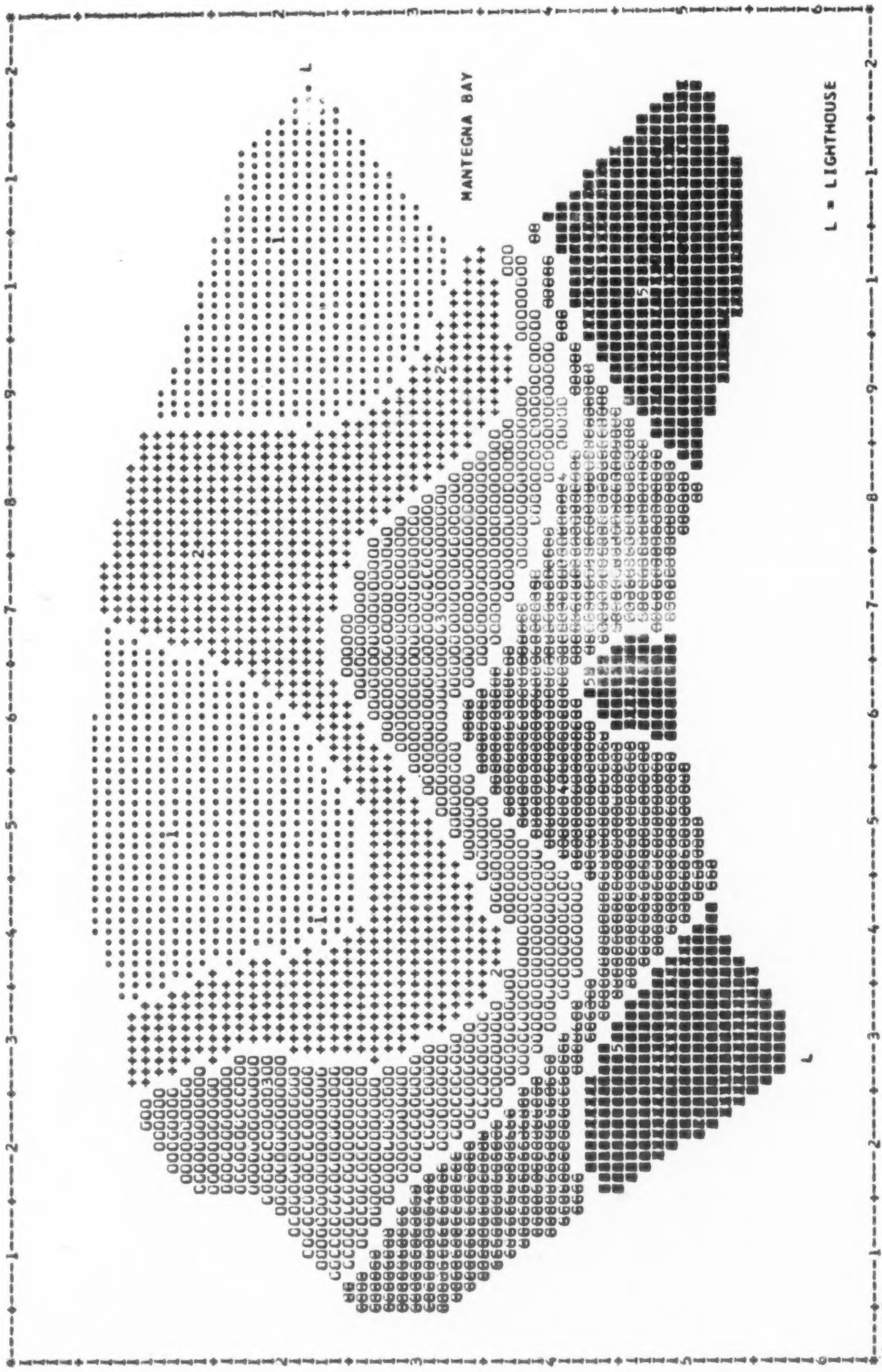
continued

```
                                                  DATA POINTS REPRESENT LOCATIONS OF PLANTATIONS USED FOR SAMPLING

DATA VALUE EXTREMES ARE        -0.00      98.41

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
        ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

 MINIMUM      -0.00      28.81      53.41      70.34      80.13
 MAXIMUM      28.81      53.41      70.34      80.13     100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              28.81      24.60      16.93       9.79      19.87

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2          3          4          5
          ==================================================
          .........  +++++++++  000000000  888888888  █████████
          .........  +++++++++  000000000  888888888  █████████
 SYMBOLS  ....1....  ++++2++++  000030000  888848888  ████5████
          .........  +++++++++  000000000  888888888  █████████
          .........  +++++++++  000000000  888888888  █████████
          ==================================================
  FREQ.          3          3          3          3          3
         1  I..1..I    I++2++I    I00300I    I88488I    I██5██I
         2  I..1..I    I++2++I    I00300I    I88488I    I██5██I
         3  I..1..I    I++2++I    I00300I    I88488I    I██5██I
TIME =  643.9

A-OUTLINE
---------

VERTEX           DOWN    ACROSS

                 ISLAND    1

(    1)           0.66      4.15                                   E0484800
(    2)           0.66      5.79                                   E0484900
(    3)           0.82      6.29                                   E0485000
(    4)           0.83      7.34                                   E0485100
(    5)           1.32      8.95                                   E0485200
(    6)           1.48      9.22                                   E0485300
(    7)           2.13     11.22                                   E0485400
(    8)           2.80     11.87                                   E0485500
(    9)           3.94     10.49                                   E0485600
(   10)           4.20     10.27                                   E0485700
(   11)           4.60     10.45                                   E0485800
(   12)           6.17     11.80                                   E0485900
(   13)           6.47     11.81                                   E0486000
(   14)           6.86     10.89                                   E0486100
(   15)           6.83     10.04                                   E0486200
(   16)           6.59      8.83                                   E0486300
(   17)           6.43      8.76                                   E0486400
(   18)           6.45      8.31                                   E0486500
(   19)           6.34      7.74                                   E0486600
(   20)           6.19      7.56                                   E0486700
(   21)           6.19      5.78                                   E0486800
(   22)           6.57      4.36                                   E0486900
(   23)           6.59      4.00                                   E0487000
(   24)           7.18      3.19                                   E0487100
(   25)           7.18      2.66                                   E0487200
(   26)           5.67      1.60                                   E0487300
(   27)           5.30      1.60                                   E0487400
(   28)           5.29      1.40                                   E0487500
(   29)           3.92      0.41                                   E0487600
(   30)           3.28      0.41                                   E0487700
(   31)           2.57      1.18                                   E0487800
(   32)           2.62      1.28                                   E0487900
(   33)           2.33      1.50                                   E0488000
(   34)           1.72      1.50                                   E0488100
(   35)           1.31      1.98                                   E0488200
(   36)           1.04      2.82                                   E0488300
(   37)           1.03      3.31                                   E0488400
AREA=      54.09          CENTER=(       3.82,       6.04)
```

continued

```
F-MAP
-----

C    CONTOUR MAP


C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT
ELECTIVE

     1 IS SAME AS PREVIOUS MAP
     2 IS SAME AS PREVIOUS MAP
     5 IS SAME AS PREVIOUS MAP
     6 SAME NUMBER OF DATA POINTS IN EACH LEVEL
    10 IS SAME AS PREVIOUS MAP
    16 VALUES OF MINUS ZERO ARE INVALID
    23 MISSING DATA POINTS DO NOT APPEAR
    27 CONTOUR MAP
TIME =  643.9




MAP   2
-------

C    CONTOUR MAP

C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT



MAP SCALE =      1.0000 INCHES ON OUTPUT MAP/UNITS ON SOURCE MAP

MAP SHOULD BE PRINTED AT   8.0 ROWS PER INCH AND  10.0 COLUMNS PER INCH

ROW    = DOWN   COORDINATE *     8.0000
COLUMN = ACROSS COORDINATE *    10.0000


DATA POINTS FOR MAP

POINT        ROW    COLUMN      DATUM      VALUE     LEVEL

   1)         19        26          1      62.28         3
   2)         12        49          2      18.89         1
   3)         24        56 NOT USED FOR CALCULATION
   4)         14        75          4      47.65         2
   5)         20       104          5       6.07         1
   6)         23        41          6      38.73         1
   7)         32        69          7      67.62         3
   8)         32        92          8      45.26         2
   9)         47        99          9      98.41         5
  10)         41        82         10      73.06         4
  11)         43        63         11      81.17         5
  12)         41        53         12      79.09         4
  13)         36        36         13      59.17         2
  14)         45        29         14      85.53         5
  15)         31        15         15      73.67         4
STANDARD SEARCH RADIUS IS          3.1543

TIME =  643.9
```

continued


MANTEGNA BAY
L = LIGHTHOUSE
L
L

```
SYMAP
C.3 MINUTES FCR MAP
TIME = 644.2
```

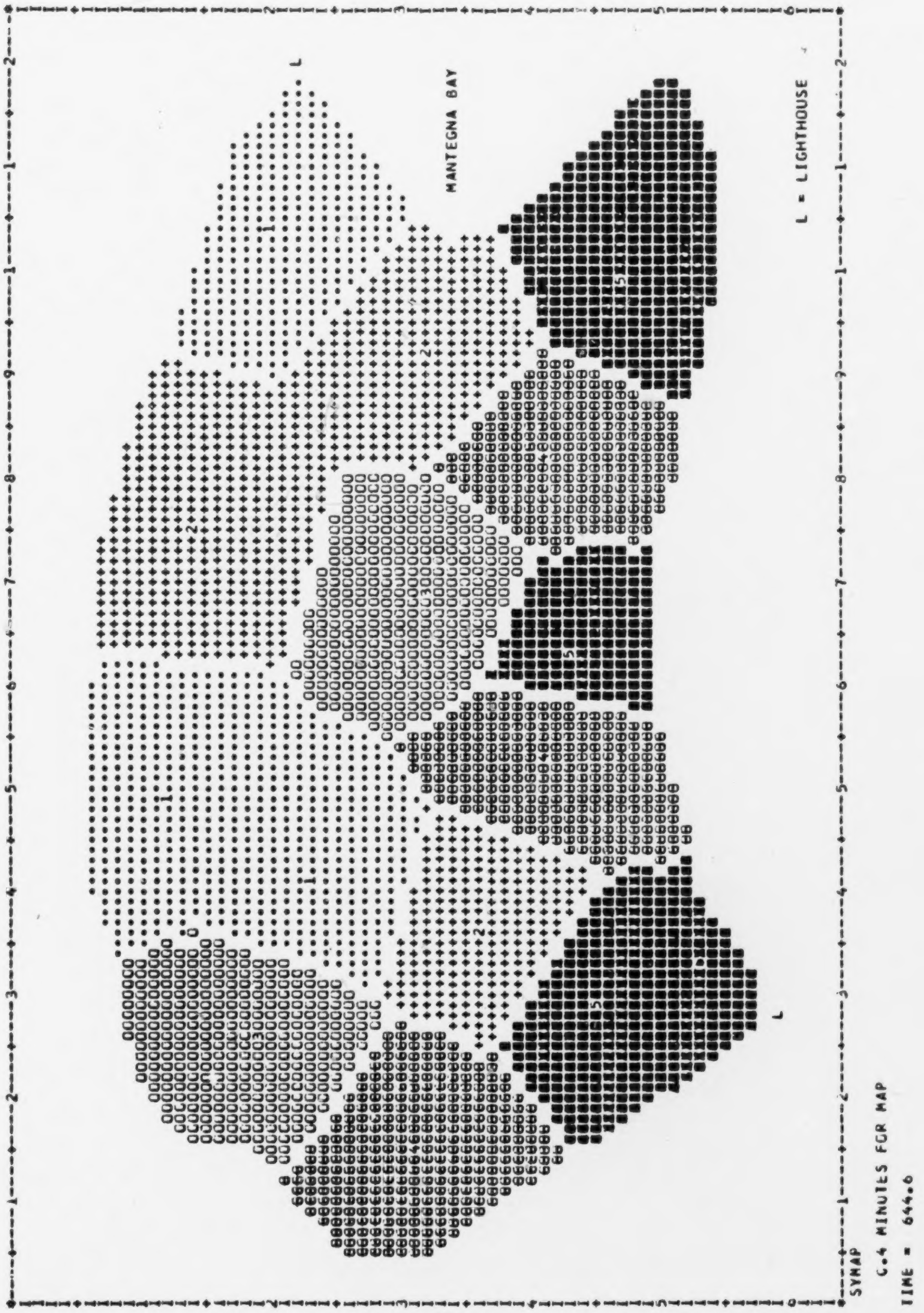
continued

```
                                                  DATA POINTS REPRESENT LOCATIONS OF PLANTATIONS USED FOR SAMPLING

DATA VALUE EXTREMES ARE        6.07      98.41


TOTAL MISSING DATA POINTS IS        1


ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
       ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       6.07      40.69      59.48      72.52      80.55
  MAXIMUM      40.69      59.48      72.52      80.55     100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

               36.86      20.01      13.88       8.55      20.71

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL          1          2          3          4          5
            ===================================================
             .......... ++++++++++ 0000000000 8888888888 ██████████
             .......... ++++++++++ 0000000000 8888888888 ██████████
  SYMBOLS    ....1..... ++++2+++++ 0000300000 8888488888 ████5█████
             .......... ++++++++++ 0000000000 8888888888 ██████████
             .......... ++++++++++ 0000000000 8888888888 ██████████
            ===================================================
  FREQ.          3          3          2          3          3
            1  I..1..I    I++2++I    I00300I    I88488I    I██5██I
            2  I..1..I    I++2++I    I00300I    I88488I    I██5██I
            3  I..1..I    I++2++I               I88488I    I██5██I

TIME =  644.2
```

continued

```
F-MAP
-----

C    PROXIMAL MAP


C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT

ELECTIVE

   12 PREVIOUS MAP OPTIONS USED
   31 FRACTIONAL EXTRAPOLATION IS        -0.0000
   36 PROXIMAL TYPE MAP
   37 VALUE COMPUTED INDEPENDENTLY FOR EVERY CHARACTER

TIME =  644.2

MAP   3
-------

C    PROXIMAL MAP

C    ESTIMATED PERCENTAGE OF COCONUT ACREAGE SUFFERING FROM BLIGHT



MAP SCALE =      1.0000 INCHES ON OUTPUT MAP/UNITS ON SOURCE MAP

MAP SHOULD BE PRINTED AT   8.0 ROWS PER INCH AND  10.0 COLUMNS PER INCH

ROW    = DOWN   COORDINATE *     8.0000
COLUMN = ACROSS COORDINATE *    10.0000


DATA POINTS FOR MAP

POINT        ROW     COLUMN      DATUM      VALUE      LEVEL

   1)         19        26          1       62.28         3
   2)         12        49          2       18.89         1
   3)         24        56 NOT USED FOR CALCULATION
   4)         14        75          4       47.65         2
   5)         20       104          5        6.07         1
   6)         23        41          6       38.73         1
   7)         32        69          7       67.62         3
   8)         32        92          8       45.26         2
   9)         47        99          9       98.41         5
  10)         41        82         10       73.06         4
  11)         43        63         11       81.17         5
  12)         41        53         12       79.09         4
  13)         36        36         13       59.17         2
  14)         45        29         14       85.53         5
  15)         31        15         15       73.67         4

STANDARD SEARCH RADIUS IS         1.1152

TIME =  644.2
```

continued


MANTEGNA BAY
L = LIGHTHOUSE
L
L
SYMAP
C.4 MINUTES FGR MAP
TIME = 644.6

continued

```
                                                DATA POINTS REPRESENT LOCATIONS OF PLANTATIONS USED FOR SAMPLING

DATA VALUE EXTREMES ARE        6.07       98.41


TOTAL MISSING DATA POINTS IS        1

ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL
      ('MAXIMUM' INCLUDED IN HIGHEST LEVEL ONLY)

  MINIMUM       6.07       40.69      59.48      72.52      80.55
  MAXIMUM      40.69       59.48      72.52      80.55     100.00

PERCENTAGE OF TOTAL ABSOLUTE VALUE RANGE APPLYING TO EACH LEVEL

              36.86      20.01      13.88       8.55      20.71

FREQUENCY DISTRIBUTION OF DATA POINT VALUES IN EACH LEVEL
  LEVEL         1          2          3          4          5
          ====================================================
           ......... +++++++++ OOOOOOOOO 888888888 █████████
           ......... +++++++++ OOOOOOOOO 888888888 █████████
  SYMBOLS  ....1.... ++++2++++ OOOO3OOOO 888848888 ████5████
           ......... +++++++++ OOOOOOOOO 888888888 █████████
           ......... +++++++++ OOOOOOOOO 888888888 █████████
          ====================================================
  FREQ.         3          3          2          3          3
        1  I..1..I   I++2++I   IOO3OOI   I88488I   I██5██I
        2  I..1..I   I++2++I   IOO3OOI   I88488I   I██5██I
        3  I..1..I   I++2++I             I88488I   I██5██I
TIME =  644.6
```

continued

COST ESTIMATE

For the job included as the Sample Output, the total running time was approximately one minute, with charges computed at the rate of \$225./h (the rate for service when memory used > 70,000). In general, the number of maps that may be produced in one minute of processing time may vary from one to three, and the amount of memory required will usually exceed 70K.

Approximate charge to user = computer time + consulting, handling, and postage + network overhead

= \$3.75 + \$7.50 + network overhead

Note: The handling fee is calculated at a rate of \$7.50/h and only one hour's charge is included.

CONTENTS—SYMAP

pages	
1,2	Identification & Abstract
3,4	User Instructions
5–16	I/O
17	Cost—Contents

DESCRIPTIVE TITLE	Transportation Planning Package
CALLING NAME	TRAN/PLAN
INSTALLATION NAME	The Florida State University Computing Center
AUTHOR(S) AND AFFILIATION(S)	Charles E. Akers William T. Gaupin The Florida State University Computing Center
LANGUAGE	Primary Language: FORTRAN IV Secondary Language: COMPASS Assembly Language
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Programs generally available through the CDC users group. FSU will make them available to EIN members.
CONTACT	William T. Gaupin, Computing Center, The Florida State University, Tallahassee, Fla. 32306 Tel.: (904) 599-4770

FUNCTIONAL ABSTRACT

The Transportation Planning Package incorporates a set of analytical techniques that enable the user to estimate future transportation requirements and evaluate proposed systems. The collection of survey techniques, analysis method, and computer programs used by TRAN/PLAN have evolved over the past two decades through studies supported by State Highway Departments, U.S. Bureau of Public Roads, and the U.S. Department of Housing and Urban Development. The TRAN/PLAN programs perform the following functions, (1) process data accumulated from inventories or surveys of existing transportation facilities, (2) calibrate and analyze several parameters for a regional transportation network, and (3) predict future intraregional transportation demands. The accuracy of future estimates depends heavily upon the choice of a suitable model, effective intermediate analysis-of-program output, and iterative recalibration of model parameters. Reference 6 explains the overall purpose of transportation planning systems in greater detail.

continued

The TRAN/PLAN Package consists of the following subprograms[1].

(a)	RELINK	Relink nodes of network
(b)	NETWORK	Build and edit network
(c)	NETDVR	Network report generator
(d)	MINPATH	Build minimum paths
(e)	SKIM	Skim (summarize) tape of trees
(f)	COLLECT	Trip data collector
(g)	TRPBLDR	Build trip tables
(h)	ADDER	Add selected trip tables
(i)	SPLITER	Split trips by direction
(j)	UPDATE	Update trip volumes
(k)	MERGE	Merge trip tables
(l)	DEMERGE	Demerge trip tables
(m)	COMPRES	Compress or expand trip tables
(n)	SECTORS	Select sector of network
(o)	TRIPTAB	Trip-table summary generator
(p)	TRIPEND	Trip-end summary generator
(q)	GRAVITY	Gravity model
(r)	FRATAR	Fratar expansion
(s)	ASSIGN	Traffic assignment
(t)	CPACITY	Capacity restraint
(u)	MODSPLT	Modal split model
(v)	CAPRPT	Cross-reference historical-report generator
(w)	CPRSRPT	Historical-report generator
(x)	COMPARE	Statistical comparison of trip volumes
(y)	AVERAGE	Historical-record summary-report generator
(z)	TIMESUM	Time-table-report generator
(aa)	TRPFREQ	Trip frequency distribution

Restrictions which apply to all programs,

1. the maximum allowed zone (centroid) number is 650
2. the maximum allowed node number is 3000
3. the maximum number of tables (purposes) is 4
4. the maximum table number is 4
5. a stacked table may contain a maximum of 8 merged tables

REFERENCES

Akers, C.E. and Gaupin, W.T., "User Manual Transportation Programs for a CDC 6400 Computer," (The Florida State University Computing Center, November 1968; unpublished). Copies of this manual are available through the Librarian, The Florida State University Computing Center.

"Calibrating and Testing a Gravity Model for Any Size Urban Area," Bureau of Public Roads, Washington, D.C., October 1965.

continued

Manual Supplements for the Transportation Planning System, Highway and Local Government Department of South Austrailia, Adelaide, Austrailia, January 1966.

Martin, Brian V., "Minimum Path Algorithms for Transportation Planning," *Research Engineer*, December 1963.

"Modal Split," U.S. Department of Commerce, Bureau of Public Roads, Office of Planning, December 1966.

Shofer, R. and Goodyear, F., "Electronic Computer Applications in Urban Transportation Planning," Proceedings of the 22nd National Conference, Association for Computing Machinery Publication P–67, 1967.

Traffic Assignment Manual, Bureau of Public Roads, Washington, D.C., June 1964.

Transportation Planning System for the Control Data 3600 Computer, Data Centers Division of Control Data Corporation, Minneapolis, Minnesota, May 1965.

Fratar, T.J., "Vehicular Trip Distributions by Successvie Approximation," *Traffic Quarterly*, January 1954, pp. 53–65.

NAME: (TRAN/PLAN)—RELINK

FUNCTIONAL ABSTRACT

Relink takes as input, Type I Link Data Cards (see below) and relinks the network so that the largest node number does not exceed the maximum-allowed node number.

NOTES: The Link Data Cards must be Type I and have either CDC or BPR format. The BPR format may be used only with a special control card. For descriptions of other Link Data Card Types, see NETWORK [000 0040(b)].

CDC Format

JURISDICTION	A NODE	B NODE	SCREEN LINE NO.	SIGN	FLAG	LINE DIST.	CARD TYPE	S OR T	CAPY GROUP	LINK USAGE	FIELD 1	FIELD 2	LINK GP 1	LINK GP 2	S OR T	CAPY GROUP	LINK USAGE	FIELD 1	FIELD 2	LINK GP 1	LINK GP 2	CHANGE NODE NO.	CAPACITY	COUNT VOL.	CODE	CAP.	COUNT. VOL.	
											TIME OR SPEED XX.XX	TIME OR SPEED XX.XX						TIME OR SPEED XX.XX	TIME OR SPEED XX.XX									

continued

BPR Format

		LINK									A ——→ B								B ——→ A														
JURISDICTION		NODE A		NODE B		SIGN	FLAG		DISTANCE MILES		"T" OR "S"		FIELD 1	FIELD 2	AVG. MIN. 0.00 OR SPEED 000				I"S" OR BL'NK		FIELD 1	FIELD 2	AVG. MIN. 0.00 OR SPEED 000				NODE B OF LINK TO BE CHANGED		CAPACITY	COUNT			
1	2	3 4 5 6	7	8 9 10 11	12	13	14	15	16 17 18	19	20	21	22 23 24	25 26 27	28 29 30	31	32 33	34	35	36	37 38 39	40 41 42	43 44 45	46	47 48	49	50 51 52 53	54	55 56 57 58 59 60	61 62 63 64 65 66	67 68 69 70 71	72	73 74 75 76 77 78 79 80
																																4	
																																4	
																																4	

COL. 35
BLANK INDICATES A
ONE-WAY LINK

continued

NAME: (TRAN/PLAN)—NETWORK

FUNCTIONAL ABSTRACT

NETWORK converts a network description coded on Hollerith Cards to a binary form to be used by succeeding programs,

performs edits and error checking on the input data; and

computes, according to parameters provided, a cost for each link based on some amount per mile, plus some amount per unit time, plus, perhaps, a flat additional cost.

The network description input includes the number of links, the node coordinates, and the capacities/volumes for the links. The output description can be specified in terms of time, distance, or cost.

NOTES:
1. A maximum of four exits per node are allowed.
2. A maximum of (3000-MAXNODE)/5 two-way weave links are allowed, where MAXNODE is the largest node number used.
3. A maximum of 250 turn prohibitions are allowed.

Link Data Card Types

Type I [see RELINK, 000 0040(a)]

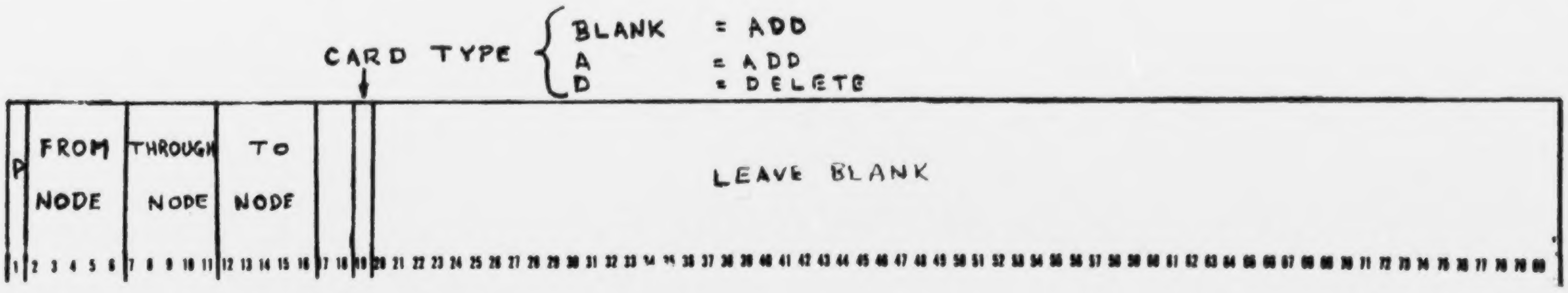
JURISDICTION	A NODE	B NODE	SCREEN LINE NO.	SIGN	FLAG	LINE DIST.	CARD TYPE	S OR T	CAPY GROUP	LINK USAGE	FIELD 1 TIME OR SPEED XX.XX	FIELD 2 TIME OR SPEED XX.XX	LINK GP 1	LINK GP 2	S OR T	CAPY GROUP	LINK USAGE	FIELD 1 TIME OR SPEED XX.XX	FIELD 2 TIME OR SPEED XX.XX	LINK GP 1	LINK GP 2	CHANGE NODE NO.	CAPACITY	COUNT VOL.	CODE	CAP.	COUNT. VOL.	
1	2 3 4 5 6	7 8 9 10 11	12	13	14	15 16 17 18	19	20	21	22	23 24 25 26	27 28 29 30	31 32	33 34	35	36	37	38 39 40 41	42 43 44 45	46 47	48 49	50 51 52 53 54	55 56 57 58 59 60	61 62 63 64 65 66	67	68 69 70 71 72 73	74 75 76 77 78 79	80

Type II: Turn Prohibition

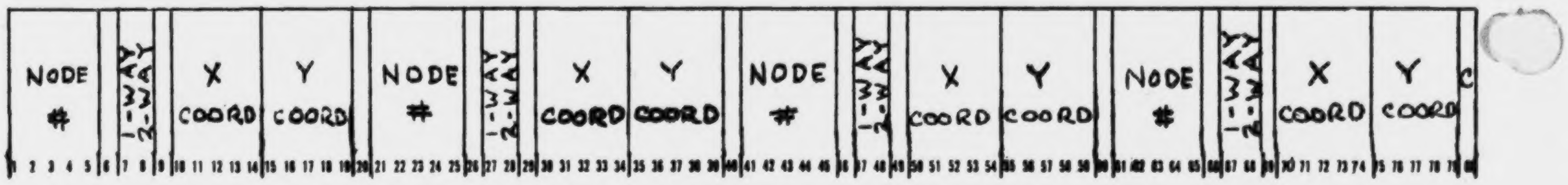
The presence of Type II Link Data Cards will produce a non-empty file on the network tape containing a table of prohibited turns. The only program which will use this file is NETDVR [000 0040(c)] which will print a summary of the table. This file will be

continued

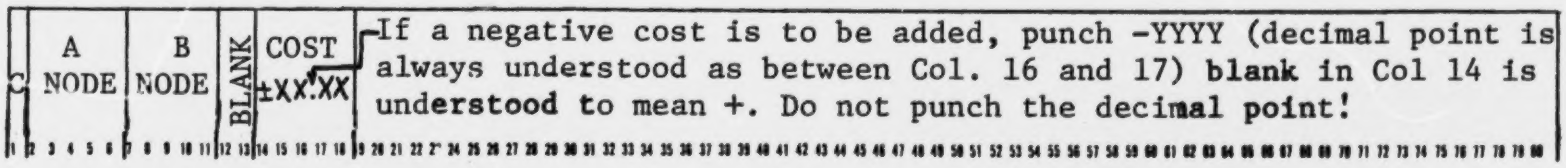
ignored by MINPATH [000 0040(d)] and ASSIGN [000 0040(s)] so that it will be necessary to recode the prohibited turns in the format specified by MINPATH when MINPATH is used.


CARD TYPE
BLANK = ADD
A = ADD
D = DELETE
P
FROM NODE
THROUGH NODE
TO NODE
LEAVE BLANK

Type III: Link Counts and Node Coordinates


NODE #
1-WAY 2-WAY
X COORD
Y COORD
NODE #
1-WAY 2-WAY
X COORD
Y COORD
NODE #
1-WAY 2-WAY
X COORD
Y COORD
NODE #
1-WAY 2-WAY
X COORD
Y COORD
C

Type IV: Cost Update Cards


C
A NODE
B NODE
BLANK
COST ±XX.XX

If a negative cost is to be added, punch -YYYY (decimal point is always understood as between Col. 16 and 17) **blank** in Col 14 is understood to mean +. Do not punch the decimal point!

continued

000 0040(c)

NAME: (TRAN/PLAN)—NETDVR

FUNCTIONAL ABSTRACT

NETDVR formats a network description and, optionally, a cost update table, a capacity/volume report, and a node-coordinate list, using the network tape as input.

NOTES: No more than four inbound links per node will be printed.

000 0040(d)

NAME: (TRAN/PLAN)—MINPATH

FUNCTIONAL ABSTRACT

MINPATH takes a network tape as input and reads as separate input, turn penalties and an unlimited number of turns one wishes to penalize or prohibit,

produces time and path descriptions for the minimum paths as described by the options used; and

optionally produces a tape containing only path descriptions to be used as input for the program ASSIGN [000 0040(s)].

The options for time/path descriptions include the production of descriptive tapes and the printing of a minimum-path trace and a time table for selected home nodes (time to each node).

000 0040(e)

NAME: (TRANS/PLAN)—SKIM

FUNCTIONAL ABSTRACT

SKIM summarizes a tape of trees from each zone to all other zones

optionally adds terminal times to particular zones; and

optionally adds or replaces update times to particular zones.

NOTES: Transit runs have not been implemented for SKIM.

continued

000 0040(f)

NAME: (TRAN/PLAN)—COLLECT

FUNCTIONAL ABSTRACT

COLLECT reformats origin/destination trip-survey data into a standard TRAN/PLAN system format; and

eliminates erroneously coded survey data.

The following types of surveys may be used: home, taxi, truck or external survey. The survey includes the following information: zone of origin and destination, purpose, mode of travel, starting and arrival time, a trip factor, land use at origin and destination, and zone of residence.

000 0040(g)

NAME: (TRAN/PLAN)—TRPBLDR

FUNCTIONAL ABSTRACT

TRPBLDR builds tables containing zone-to-zone trip data,

assigns to certain trips a trip-volume factor based upon selected criteria,

produces a tape containing the tables of zone-to-zone trip data,

produces a trip-end summary tape containing totals of all origins, destinations, and intrazonal trips for each zone; and

optionally prints a trip-end summary.

The criteria used for selecting trips include purpose, mode of travel, land and use at origin and destination, and both limits on starting and arrival times.

NOTES: The maximum number of criteria sets per table is ten.

continued

000 0040(h)

NAME: (TRAN/PLAN)—ADDER

FUNCTIONAL ABSTRACT

ADDER adds selected trip tables to the volume tape from TRPBLDR [000 0040(g)], GRAVITY [000 0040(q)], FRATAR [000 0040(r)], or MERGE [000 0040(k)]. Each table must contain the same number of zones.

000 0040(i)

NAME: (TRAN/PLAN)—SPLITER

FUNCTIONAL ABSTRACT

SPLITER divides the trips into and out of a zone based on the percentage given by the input parameter.

000 0040(j)

NAME: (TRAN/PLAN)—UPDATE

FUNCTIONAL ABSTRACT

UPDATE factors, adds to, or subtracts from zone-to-zone trip volumes any specific volume over any range of zones.

000 0040(k)

NAME: (TRAN/PLAN)—MERGE

FUNCTIONAL ABSTRACT

MERGE accepts as input either a single tape in demerged format or separate tapes containing a single table each, and produces a tape in merged format. A stacked table may contain a maximum of eight merged tables.

continued

000 0040(1)

NAME: (TRAN/PLAN)—DEMERGE

FUNCTIONAL ABSTRACT

DEMERGE produces one or more tapes in demerged format from an input tape in merged format.

000 0040(m)

NAME: (TRAN/PLAN)—COMPRES

FUNCTIONAL ABSTRACT

COMPRES is used to compress or expand the trip-table array by al tering the zonal composition of the districts or by adding empty districts.

NOTES: All zones must be assigned to some district. In the event of a zone being assigned to more than one district, the last assignment will be used.

000 0040(n)

NAME: (TRAN/PLAN)—SECTORS

FUNCTIONAL ABSTRACT

SECTORS selects zone-to-zone trips with production or attractions in specified zone ranges,

sets all remaining zone-to-zone trips to zero; and

produces a tape which may be used for an assignment of trips to or from a sector of the study area.

continued

000 0040(o)

000 0040(o)

NAME: (TRAN/PLAN)—TRIPTAB

FUNCTIONAL ABSTRACT

TRIPTAB takes a zone-to-zone volume tape or a skim-tree tape and produces a summary table of each selected zone of origin.

NOTES: A stacked table may contain a maximum of eight merged tables.

000 0040(p)

000 0040(p)

NAME: (TRAN/PLAN)—TRIPEND

FUNCTIONAL ABSTRACT

TRIPEND reads a trip-end summary tape or a zone-to-zone volume tape (in either standard or sorted format) and produces a table of the number of origins, destinations, intrazonals, and total trips for each zone.

000 0040(q)

000 0040(q)

NAME: (TRAN/PLAN)—GRAVITY

FUNCTIONAL ABSTRACT

GRAVITY calculates future or synthetic trips by means of the gravity-model distribution equation[1],

iterates to desired attractions (≤ 6: iterations),

iterates travel times to trip length using origin/destination volumes (≤ 3: iterations),

optionally produces a future zone-to-zone volume tape by purpose,

optionally produces a report of accessibility indices by zone and by purpose upon completion of the first iteration,

optionally produces a report and punches the final travel-time factors,

continued

000 0040(q)

optionally produces a graph of the trip-length frequency of the gravity model trips and the origin/destination trips, if any,

optionally prints a report of the trip-length frequency tables,

optionally prints a table of the final coefficients by purpose,

optionally prints a trip-length comparison report by purpose; and

optionally prints a report of given attractions versus the computed attractions by purpose.

NOTES:

A. The final travel-time factors (F-factors) in the gravity model may be represented by the function F(t,p), where t is the time from 1 to 200 minutes and p is the purpose number from 1 to 4. There are three possible ways in which the initial F-factors may be determined.

1. The F-factors can be read from F-factor Data Cards.
2. The F-factors can be defined for all purposes by the equation

$$F(t,p) = 10^5/t^2,$$

   for all t from 1 to MAXTIME where MAXTIME is the maximum time intended for the F-factors (≤ 200).
3. Four coefficients can be read from Coefficient Data Cards for each purpose and the F-factors defined by the equation

$$F(t,p) = \exp(C_0 + C_1 X t + C_2 X t^2 + C_3 X t^3),$$

   for all t from 1 to MAXTIME.

B. The maximum number of districts is 100.

REFERENCES

1. "Calibrating and Testing a Gravity Model for Any Size Urban Area," Bureau of Public Roads, Washington, D.C., October 1965.

continued

000 0040(r)

NAME: (TRAN/PLAN)—FRATAR

FUNCTIONAL ABSTRACT

FRATAR expands trips by the Fratar method[1], optionally prints the growth factors, total trip-ends and a trip-end summary, and produces a future zone-to-zone volume tape with a report of future trip-ends and final growth factors.

REFERENCES

1. Fratar, T.J., "Vehicular Trip Distributions by Successive Approximation," *Traffic Quarterly*, January 1954, pp. 53–65.

000 0040(s)

NAME: (TRAN/PLAN)—ASSIGN

FUNCTIONAL ABSTRACT

ASSIGN takes as input a network tape, a zone-to-zone volume tape, and a path tape and assigns the trip volumes to the minimum paths according to selected parameters,

optionally produces a link-volume report and a jurisdiction summary,

optionally produces a turning-movement report; and

optionally produces a loaded-network tape.

Parameters include percentage of trip volumes to be loaded and the designation of freeway nodes.

NOTES: Turning volumes may be recorded at those nodes which are not centroids. The maximum trip volume per one-way link is 65,535.

000 0040(t)

NAME: (TRAN/PLAN)—CPCITY

FUNCTIONAL ABSTRACT

CPCITY updates the time file on the network tape according to the capacity-restraint formula[1]; and

prints a summary of the updated time file.

continued

000 0040(t)

000 0040(t)

Either measured volumes or capacities may be used for the update calculations.

REFERENCE

1. *Traffic Assignment Manual*, Bureau of Public Roads, Washington, D.C. , June 1964, pp. V18—V21.

000 0040(u)

000 0040(u)

NAME: (TRAN/PLAN)—MODSPLT

FUNCTIONAL ABSTRACT

MODSPLT has not been fully implemented at this time.

000 0040(v)

000 0040(v)

NAME: (TRAN/PLAN)—CAPRPT

FUNCTIONAL ABSTRACT

CAPRPT takes loaded network tapes from ASSIGN [000 0040(s)] as input and prints an historical report of the assigned volumes by link and reverse link, with the average volume assignment for each link.

If no cross reference is desired, the program CPRSRPT [000 0040(w)] must be used.

continued

000 0040(v)

000 0040(w)

NAME: (TRAN/PLAN)—CPRSRPT

FUNCTIONAL ABSTRACT

CPRSRPT takes loaded network tapes from ASSIGN [000 0040(s)] as input and prints an historical report of the assigned volumes by link, with the average volume assignment for each link.

No cross reference is provided by CPRSRPT. If one is desired, the program CAPRPT [000 0040(v)] must be used.

000 0040(x)

NAME: (TRAN/PLAN)—COMPARE

FUNCTIONAL ABSTRACT

COMPARE conducts a statistical volume comparison of two binary-trip tapes or two loaded-network tapes,

optionally prints a table of individual volume differences for the tapes; and

prints a series of tables of frequency distributions and analyses-of-volume differences according to given volume groups.

NOTES: The maximum number of volume or difference groups is 20.

REFERENCES

For a further discussion of COMPARE (PR—124), see chapter V and A—18ff of "Calibrating and Testing a Gravity Model for Any Size Urban Area," October 1965 and III—74 of the *Traffic Assignment Manual*, June 1964 by the Bureau of Public Roads.

continued

000 0040(y)

NAME: (TRAN/PLAN)—AVERAGE

FUNCTIONAL ABSTRACT

AVERAGE prints summary reports of specified files based on the average of the volumes and times from the input tapes.

The files are from historical-record tapes from ASSIGN [000 0040(s)]. Output consists of a required jurisdiction report, optional link-volume reports, and turning-movement reports.

000 0040(z)

NAME: (TRAN/PLAN)—TIMESUM

FUNCTIONAL ABSTRACT

TIMESUM selects any zones from an input tape and prints a time table of the travel times from each zone to all other zones if any times are greater than a specified maximum time.

The selection of the zones to be summarized is identical to the method used in COMPRES [000 0040(m)].

000 0040(aa)

NAME: (TRAN/PLAN)—TRPFREQ

FUNCTIONAL ABSTRACT

TRPFREQ prints a trip-frequency distribution and a distributional histogram of interzonal-travel time versus trips.

USER INSTRUCTIONS

Information concerning the preparation of data and subprogram usage can be obtained by consulting the reference listed below.

REFERENCES

Akers, C.E. and Gaupin, W.T., "User Manual Transportation Programs for a CDC 6400 Computer," (The Florida State University Computing Center, November 1968; unpublished). Copies of this manual are available through the Librarian, The Florida State University Computing Center.

SAMPLE INPUT/OUTPUT

A sample output for a 30-zone, 1262-node transportation study (approximately 300 pages of output) is available at the EIN office. Those interested may refer to this copy or may order a copy at the cost of reproduction and mailing.

COST ESTIMATE

It is not possible to estimate the cost of a run of the TRAN/PLAN package owing to the number and variety of subprograms and options. The rate for use of the TRAN/PLAN package is set at $400/computational unit (sum of central- and peripheral-processor time in hours). As a *very* rough guide, a sample run for a 30-zone, 1262-node transportation study (approximately 300 pages of output) required approximately two minutes of central-processor time and eleven minutes of peripheral-processor time.

Approximate charge to user = computer time + consulting and handling + network overhead

= $87.00 + $7.50 + network overhead

CONTENTS—TRAN/PLAN

pages

1–18	Identification & Abstract
19	User Instructions
21	I/O
23	Cost—Contents

DESCRIPTIVE TITLE	A Package of Three FORTRAN Programs for Computerized Assistance in the Instruction of Beginning and Remedial Reading and the Evaluation of Such Instruction
CALLING NAME	DOVACK (a) DOVA; (b) DOVB; (c) REPORT
INSTALLATION NAME	Computer Center, The Florida State University
AUTHOR(S) AND AFFILIATION(S)	Florine Way, Project Director, ESEA Title III, Jefferson County, Florida, Board of Public Instruction
LANGUAGE	FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	William Petty, Computer Center, The Florida State University, Tallahassee, Fla. 32306 Tel.: (904) 599-3418

FUNCTIONAL ABSTRACT

DOVACK is a program package for accepting unstructured student dictations as input and returning these dictations in a structured form for study by the student of his own individual vocabulary. Each distinct English word is separated from the text of the dictation and listed alphabetically for comparison by the student of the word in and out of context. Each student's vocabulary is retained in a permanent file that is updated each time a new dictation is entered. Random-sample vocabulary-recognition tests may be prepared at the user's option from the individual student's vocabulary list. Punched-card information is provided at test time for use by the instructor in evaluating the success of the instruction. To facilitate the use of the program from the instructional site via remote terminals, the tasks are broken into three segments, each handled by a separate program.

(a) DOVA

...scans the unstructured dictations, echoes them with numbered

continued

lines, breaks the text into separate English words, alphabetizes and formats the word lists. The word lists, word frequency of occurrence, and location (line number) in the dictation are passed to DOVB via magnetic tape.

(b) DOVB

...merges each student's word list with the permanent files kept of the student's vocabulary. Two files are kept, one permanent (tape 1), the other semipermanent (tape 2). Random-sample vocabulary-recognition tests for the student group may be given from either file (or both). When a test is given from the semipermanent file, the file is erased, thus providing the capability of testing only over new words used since the last vocabulary test. The number of words on a test is determined by the formula $N/[1.+(N-1.)/40.]$, where N is the total number of distinct words dictated. When tests are given, cards are prepared containing information on each student's vocabulary for use by REPORT.

(c) REPORT

...accepts the punched cards from DOVB, augmented by results of tests from the instructor and summarizes the instructional results in terms of new words learned by the student.

000 0041
(b)

DOVB USER INSTRUCTIONS

Input

Tape from DOVA and permanent file tapes. (These tapes should be empty initially.)

Output

DOVB generates new permanent tapes. The Output to the user is the random-sample vocabulary-recognition tests and associated punch cards (if tests were requested).

continued

DOVA USER INSTRUCTIONS

Input

The first line on the input card should contain the test requests to be transmitted via tape 10 to DOVB. If a test is to be prepared from the intermediate tape, type YES in Cols. 1–3. If a test is desired from the permanent tape, type YES in Cols. 4–6. Any other entry on line 1 is ignored. Following line 1, the student dictations appear. The first line of each dictation contains a 6-character identification, a dictation number, and the student's name, separated by commas. On successive lines, the dictation is typed. The end of the dictation is signaled by *END any place on the line.

Output

Output to the user is in the form of echoed dictations, with lines numbered, followed by an alphabetized list of the distinct words occurring in the dictation and the line number of their first occurrence.

Output on tape is in the form of word lists, with line number, frequency of occurrence, and dictation number associated with each word.

continued

REPORT USER INSTRUCTIONS

Input

Punched cards from DOVB, with the additional information from the instructor added to the cards.

(a) Class card

Columns	*Content*
1– 3	number of students in class
4–13	date of report

(b) Student card

Columns	*Field*	*Content*
1–20	1	student name
21–26	2	student identification
27–32	3	not used
33–42	4	total number of English words used
43–52	5	total number of distinct English words used
53–55	6	number of class periods present this test cycle
56–60	7	number of dictations made this test cycle
61–65	8	number of words on RSVR test
66–70	9	number of words correctly read from test
71–80	10	date ending student's test group

Note: Fields 1, 2, 4, 5, and 8 are punched by DOVB. Other fields must be added by instructor.

Output

For each class, the following output is prepared—

(a) student summary report for each student in the class
(b) class summary report
(c) plot of total words used versus total distinct words used (type/token ratio) against RSVR scores
(d) histogram of the estimated number of new words learned by the students in this test-cycle period
(e) histogram of the total number of new words dictated in this cycle

The following data restrictions should be observed.

Maximum number of students: 1000
Maximum number of words per dictation: 2000
Line length in dictations $\leq$ 60 characters

continued

000 0041
(c)

Maximum English-word size: 20 characters
Maximum dictation number: 999
Maximum student-name length: 20 characters
Identification length: 6 characters

SAMPLE INPUT (TO DOVA)

```
105111.1,RUBY [illegible]
      ONCE UPON A TIME THERE LIVED THREE BEARS. MOTHER BEAR.
FATHER BEAR. AND BABY BEAR.  THE MOTHER BEAR COOKED SOME
SOUP AND IT WAS TOO HOT.  SO THE MOTHER BEAR SAID LET≠S
GO ON A WALK UNTIL WE THINK IT≠S ABOUT COLD.  THEN
GOLDILOCKS CAME BY.  SHE SOT IN THE BIG FATHER BEAR CHAIR
BUT IT WAS TOO HARD.  SHE SOT IN THE MOTHER BEAR CHAIR BUT
IT WAS TOO SOFT.  SHE SOT IN THE BABY BEAR CHAIR AND IT
WAS JUST RIGHT.    SHE BUST IT ALL UP.  GOLDILOCKS WENT IN
THE BEDROOM AND SHE LAID IN THE FATHER BEAR BED. BUT IT
WAS TOO HARD.  SHE LAID IN THE MOTHER BEAR BED. BUT IT
WAS TOO SOFT.  SHE LAID IN THE BABY BEAR BED. AND IT WAS
JUST RIGHT.  SHE WENT TO SLEEP.  THE THREE LITTLE BEARS
CAME BACK.  THE FATHER BEAR SAID SOMEBODY≠S BEEN SITTING IN
MY CHAIR.  THE MOTHER BEAR SAID SOMEBODY≠S BEEN SITTING IN
MY CHAIR.  THE BABY BEAR SAID SOMEBODY≠S BEEN SITTING IN
MY CHAIR AND BROKE IT ALL UP.  THE FATHER BEAR SAID SOMEBODY
HAS BEEN LAYING IN MY BED.  THE MOTHER BEAR SAID SOMEBODY
HAS BEEN LAYING IN MY BED.  THE BABY BEAR SAID SOMEBODY HAS
BEEN LAYING IN MY BED. AND HERE SHE IS.  GOLDILOCKS WOKE
UP AND SHE RAN OUT THE DOOR. ≠END
```

SAMPLE OUTPUT (FROM DOVA)

```
                         RUBY SEABROOKS
                   ******* DICTATION  1  *******

     ONCE UPON A TIME THERE LIVED THREE BEARS. MOTHER BEAR.       1
FATHER BEAR. AND BABY BEAR.  THE MOTHER BEAR COOKED SOME          2
SOUP AND IT WAS TOO HOT.  SO THE MOTHER BEAR SAID LET#S           3
GO ON A WALK UNTIL WE THINK IT#S ABOUT COLD.  THEN                4
GOLDILOCKS CAME BY.  SHE SOT IN THE BIG FATHER BEAR CHAIR         5
BUT IT WAS TOO HARD.  SHE SOT IN THE MOTHER BEAR CHAIR BUT        6
IT WAS TOO SOFT.  SHE SOT IN THE BABY BEAR CHAIR AND IT           7
WAS JUST RIGHT.   SHE BUST IT ALL UP.  GOLDILOCKS WENT IN         8
THE BEDROOM AND SHE LAID IN THE FATHER BEAR BED. BUT IT           9
WAS TOO HARD.  SHE LAID IN THE MOTHER BEAR BED. BUT IT           10
WAS TOO SOFT.  SHE LAID IN THE BABY BEAR BED. AND IT WAS         11
JUST RIGHT.  SHE WENT TO SLEEP.  THE THREE LITTLE BEARS          12
CAME BACK.  THE FATHER BEAR SAID SOMEBODY#S BEEN SITTING IN      13
MY CHAIR.  THE MOTHER BEAR SAID SOMEBODY#S BEEN SITTING IN       14
MY CHAIR.  THE BABY BEAR SAID SOMEBODY#S BEEN SITTING IN         15
MY CHAIR AND BROKE IT ALL UP.  THE FATHER BEAR SAID SOMEBODY     16
HAS BEEN LAYING IN MY BED.  THE MOTHER BEAR SAID SOMEBODY        17
HAS BEEN LAYING IN MY BED.  THE BABY BEAR SAID SOMEBODY HAS      18
BEEN LAYING IN MY BED. AND HERE SHE IS.  GOLDILOCKS WOKE         19
UP AND SHE RAN OUT THE DOOR.                                     20


WORD...........LINE  WORD...........LINE  WORD...........LINE


A                 1  HARD              6  SLEEP            12
ABOUT             4  HAS              17  SO                3
ALL               8  HERE             19  SOFT              7
AND               2  HOT               3  SOME              2
BABY              2  IN                5  SOMEBODY         16
BACK             13  IS               19  SOMEBODY#S        3
BEAR              1  IT                3  SOT               5
BEARS             1  IT#S              4  SOUP              3
BED               9  JUST              8  THE               2
BEDROOM           9  LAID              9  THEN              4
BEEN             13  LAYING           17  THERE             1
BIG               5  LET#S             3  THINK             4
BROKE            16  LITTLE           12  THREE             1
BUST              8  LIVED             1  TIME              1
BUT               6  MOTHER            1  TO               12
BY                5  MY               14  TOO               3
CAME              5  ON                4  UNTIL             4
CHAIR             5  ONCE              1  UP                8
COLD              4  OUT              20  UPON              1
COOKED            2  RAN              20  WALK              4
DOOR             20  RIGHT             8  WAS               3
FATHER            2  SAID              3  WE                4
GO                4  SHE               5  WENT              8
GOLDILOCK         5  SITTING          13  WOKE             19
```

SAMPLE OUTPUT (FROM DOVB)

```
          THESE ARE SIX DAY  RSVR TESTS



     JOAN RUSSELL
  1. A
  2. ARE
  3. BETTER
  4. CAME
  5. DICTATE
  6. EVERY
  7. GODMOTHER
  8. HAT
  9. I
 10. JERRY
 11. LIQUOR
 12. MEMBER
 13. NEVER
 14. OH
 15. PINTS
 16. SAW
 17. SISTERS
 18. STORY
 19. THEM
 20. TOLD
 21. WAS
 22. WHY
```

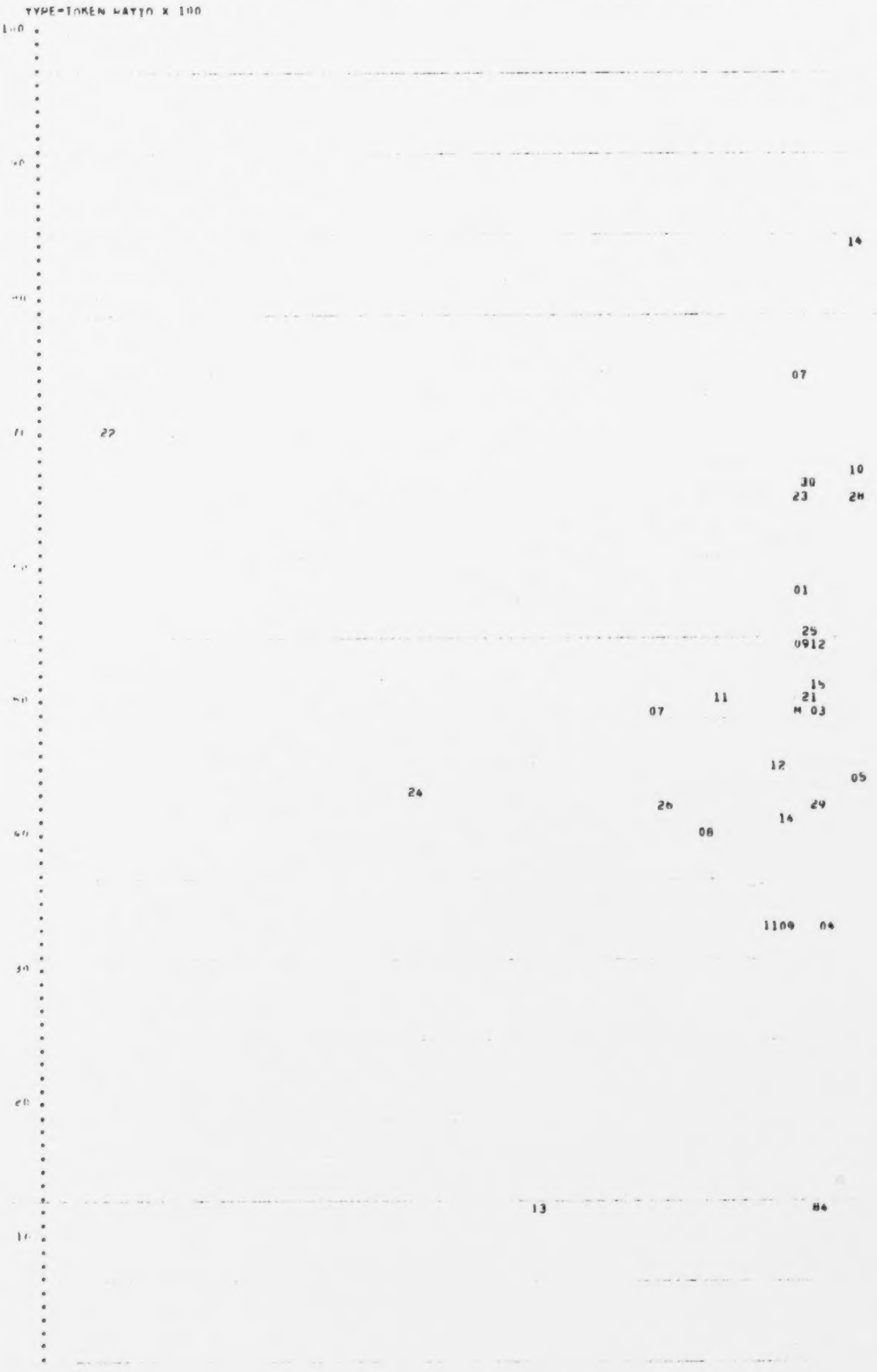
SAMPLE OUTPUT (FROM REPORT)

```
                    ANTHONY FEACHER      IN GRADE 05
     PUPIL PROGRESS REPORT FOR THE 6-DAY CYCLE ENDING  2-26-69
     ________________________________________________________________

1.  NO. CLASS PERIODS (CP) PRESENT THIS 6-DAY CYCLE.........................     5
2.  AVERAGE NO. OF DICTATIONS PER CP PRESENT................................   .20
3.  AVERAGE NO. OF WORDS DICTATED PER CP PRESENT............................ 12.80
4.  AVERAGE NO. OF NEW WORDS DICTATED PER CP PRESENT........................  7.40
5.  TYPE-TOKEN RATIO (=NO. DISTINCT WORDS/TOTAL NO. WORDS DICTATED).........   .58
6.  NO. WORDS ON RANDOM SAMPLE VOCABULARY RECOGNITION (RSVR) TEST...........    15
7.  NO. WORDS CORRECT ON RSVR TEST..........................................    14
8.  ESTIMATED PER CENT OF HIS OWN NEW WORDS PUPIL LEARNED...................    93
9.  ESTIMATED NO. OF HIS OWN NEW WORDS PUPIL LEARNED........................    35
10. ESTIMATED RATE OF LEARNING NEW WORDS (PER CP)...........................     7
```

```
                                  GRADE 06
     CLASS PROGRESS REPORT FOR THE 6-DAY CYCLE SERIES ENDING
______________________________________________________________________________
                                       TOTAL  HIGH   LOW RANGE    MEAN      SD
______________________________________________________________________________
1.  NO. CLASS PERIODS PRESENT...........  172     6     4     2    5.73     .51
2.  NO. DICTATIONS......................   40     4     1     3    1.33     .75
3.  NO. WORDS DICTATED.................. 7488   830    15   815  249.60  225.08
4.  NO. NEW WORDS DICTATED.............. 2704   212    10   202   90.13   54.48
5.  TYPE-TOKEN RATIO.................... 1481    84    12    72   49.37   16.32
6.  NO. WORDS ON RSVR TEST..............  552    23     8    15   18.40    3.53
7.  NO. WORDS CORRECT ON RSVR TEST......  480    22     1    21   16.00    4.43
8.  ESTIMATE PERCENT NEW WORDS LEARNED.. 2609   100     7    93   86.97   19.04
9.  ESTIMATE NO. NEW WORDS LEARNED...... 2364   203     2   201   78.80   51.44
10. ESTIMATE RATE LEARNING NEW WORDS....  413    41     0    41   13.77    9.11
```

continued

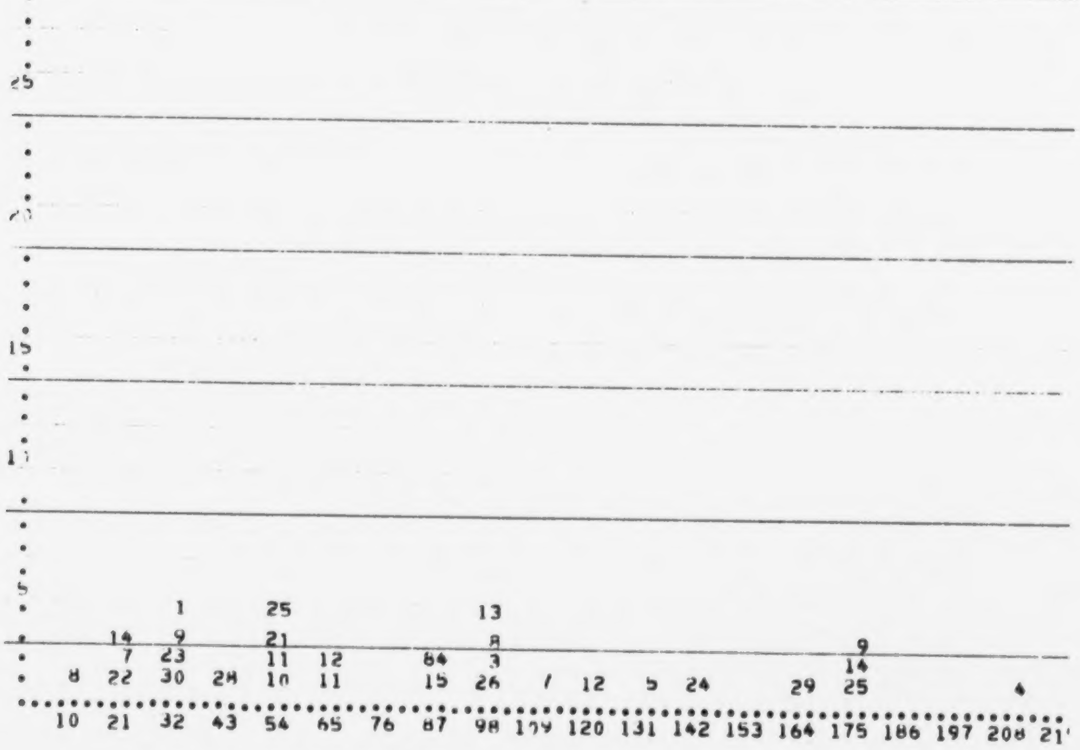
A PLOT OF TYPE-TOKEN RATIOS AGAINST RSVW SCORES FOR GRADE 06. DATE:



continued

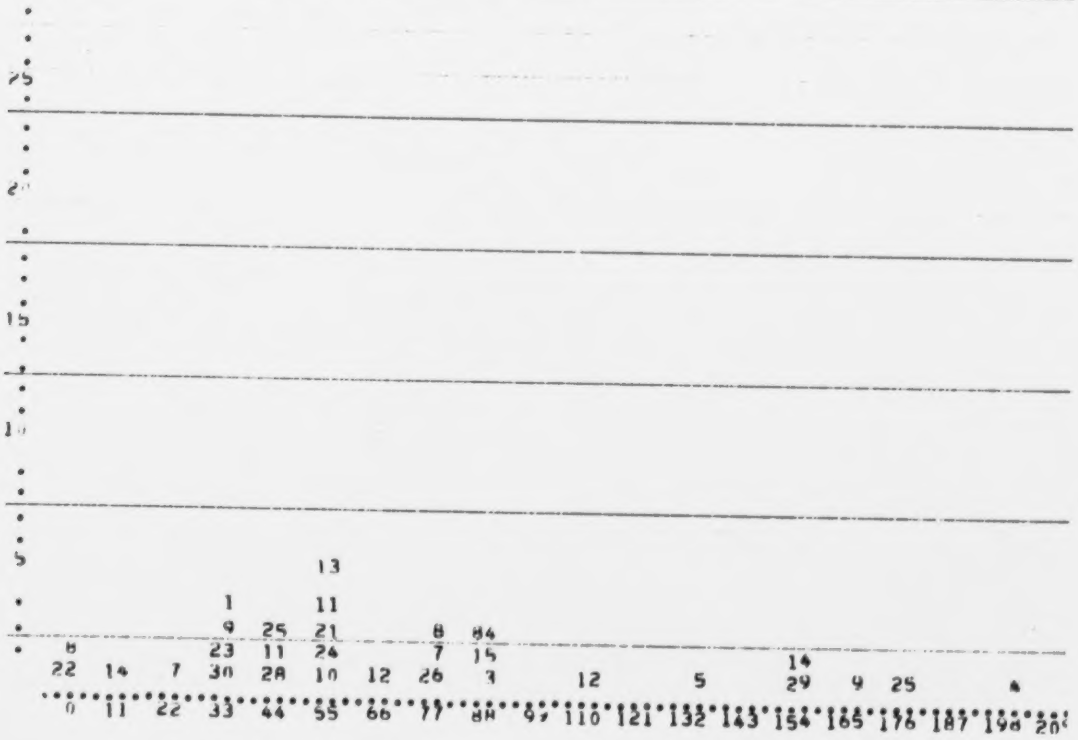
000 0041
(c)

HISTOGRAM OF THE TOTAL NUMBER OF NEW WORDS DICTATED THIS CYCLE
(STUDENT POSITION INDICATED BY ID)



MEAN= 90.13, MEDIAN= 72, STANDARD DEVIATION = 54.48

HISTOGRAM OF THE ESTIMATED NUMBER OF NEW WORDS LEARNED THIS CYCLE
(STUDENT POSITION INDICATED BY ID)



000 0041
(c)

COST ESTIMATE

The amount of memory required to run DOVA is $45{,}000_8$ words and that for DOVB is $63{,}000_8$ words, thereby causing computer charges to be calculated at the rate of $150./computational unit (hour). The typical time for a complete DOVACK run is about three minutes (real time); however, the amount of time varies with the length of the dictations and the number of dictations for the run. Also, as DOVACK private files become longer, DOVB takes an increasingly greater length of time to run.

Therefore, *for a run of 3 minutes*,

Approximate charge to user = computer time + postage, handling, and consulting + network overhead
= $7.50 + $7.50 + network overhead
= $15.00 + network overhead

CONTENTS—DOVACK

pages

1,2 Abstract & Identification
3–6 User Instructions
7–12 I/O
13 Cost—Contents

DESCRIPTIVE TITLE	FORTRAN Program for Computing a Full Set of Canonical Correlations Relating Two Sets of Measurements
CALLING NAME	CANON
INSTALLATION NAME	University of Pittsburgh
AUTHOR(S) AND AFFILIATION(S)	William W. Cooley, Department of Educational Research, University of Pittsburgh Paul R. Lohnes, Department of Educational Psychology, State University of New York, Buffalo
LANGUAGE	FORTRAN II
COMPUTER	IBM 360/50 IBM 7090
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	**Mr. John Nold, Assistant Director for** Services, Computer Center, University of Pittsburgh, 800 Cathedral of Learning, Pittsburgh, Pa. 15213 Tel.: (412) 621-3500 ext. 7185

FUNCTIONAL ABSTRACT

CANON is a FORTRAN II program that may be utilized for studying the interrelations between two sets of measurements made on the same observational units. Thus, the user may use the routine to test general hypotheses that suggest that relationships exist between two sets of variables. The canonical correlation is the maximum correlation between linear functions of the two sets of variables. Since more than one linear combination of each of the two sets of variables is often possible, the program successively computes pairs of functions subject to the condition that each is orthogonal to all other functions derived from its set of measurements.

The analytical method employed involves the partitioning of the matrix of intercorrelations (R) of the variables into four submatrices.

(1) R_{11} the intercorrelations of the predictor variables

(2) R_{22} the intercorrelations of the criteria variables
(3) R_{12} the intercorrelations of the predictor variables with the criteria variables
(4) the transpose of R_{12}

The four submatrices are then substituted into a canonical equation, the solution of which involves finding latent roots that are functionally related to sets of weights that maximize the correlation between the derived canonical variates.

CANON operates on data cards that contain the full correlation matrix (upper triangular) of order M = M1 + M2, where M1 is the number of variables in the left set and M2 is the number of variables in the right set. It is immaterial as to which set represents the predictors or criteria, the only requirement being that $M2 \leq M1$.

CANON reproduces the full correlation matrix that was used as input. In addition, it provides the canonical weights for both predictor and criteria variates, and the factor structures (correlations between each canonical factor and its associated variables) for both sets of canonical factors. Also included are measures of redundancy (the proportion of variance in one set of variables accounted for by the second set of variables) between the two sets of variables, each set given the other.

The Bartlett procedure for testing the significance of canonical correlations using chi square is provided. In addition, χ^2 tests with successive roots removed are provided in the event that the null hypothesis can be rejected.

REFERENCES

Cooley, W. W., and Lohnes, P. R., *Multivariate Procedures for the Behavioral Sciences* (John Wiley & Sons, Inc., New York, 1962; to be republished in 1969).

USER INSTRUCTIONS

Data-Format Regulations

The two sets of variables (hereafter denoted the left and right sets) have M1 and M2 variables, respectively. In addition to the requirement that $M2 \leq M1$, a further restriction is that $M1+M2=M \leq 100$. Thus, the full correlation matrix that is input to the program may not exceed an order of 100. Large jobs ($M>20$) are batch-processed, using an IBM model 7090. Jobs of lesser magnitude ($M \leq 20$) are processed using the IBM model 360/50 with the Pitt time-sharing system. Runs meeting the specification for processing using the 360/50 are likely to have a considerably shorter turnaround time.

A. Deck Setups for Submission to the IBM 360/50 ($M \leq 20$)

Control cards for each run are to be punched as follows.

Cards

1. *Dataset Creation*—This card is punched beginning in Col. 1 in the following form.

```
$$CREATE DSNAME.
```

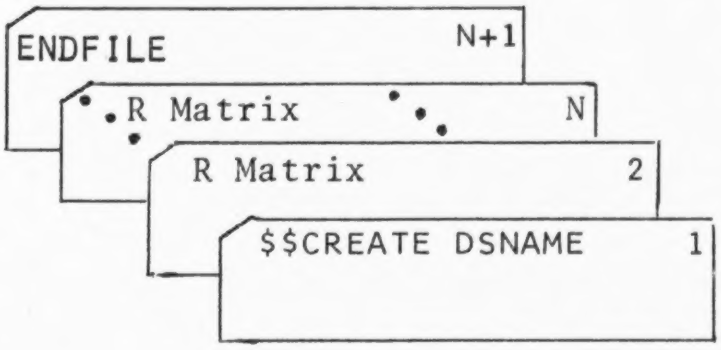
DSNAME is any set of 8 or fewer letters and/or integers, with the restriction that the first element of the set must be a letter. DSNAME *must* be a different set of characters for each unique submission.

2···N. *The Full Correlation Matrix*—Cards 2–N contain an order-M matrix of intercorrelations between the M1 and M2 variables and should be punched according to the format that the user provides as requested later in this section.

N+1. *End-of-File Card*—The final card of the data deck is punched beginning in Col. 1. The card contains the single word ENDFILE.

continued

Thus, the program deck for the short version ($M \leq 20$) of CANON should appear as follows.



To execute this version of CANON, the following information must be provided along with the dataset specified above.

(1) M1 number of variables in the left set

(2) M2 number of variables in the right set

(3) n number of observations

(4) the variable format for entering the correlation matrix. The format specifies the column locations of the data to be entered. Since the correlation matrix was punched according to a specific format in the correlation program that produced it, the format is already available to the user.

B. Deck Setups for Submission to the IBM 7090 ($M > 20$)

Control cards for each run are to be punched as follows.

Cards

1–10. *Comment Cards*—Columns 2–80 of the first 10 cards are reserved for any comments that the user may wish to head his printout. If no comments are desired, 10 blank cards are required.

continued

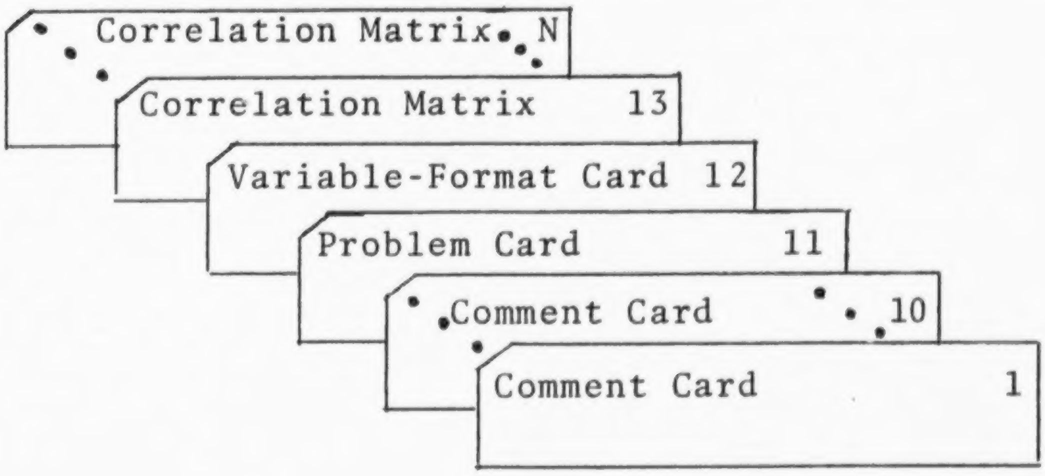
11. *Problem Card*

Columns	*Contents*
1–2	M1 number of variables in left set
3–4	M2 number of variables in right set
5–9	n number of observations

12. *Variable-Format Card for Correlation Matrix*—This format card specifies the column locations of the correlations contained on the input matrix. Since the correlation matrix has been punched according to a specific format by the program in which it was produced, the format is already available to the user. The latter format should be punched within parentheses beginning in Col. 1. For example, (10X,7F10.7)

13.··· N. *The Full Correlation Matrix*—Cards 13–N contain and order M matrix of intercorrelations between the M1 and M2 variables and should be punched according to the format punched on card 12 above.

Thus, the program deck should appear as follows.


Correlation Matrix N
Correlation Matrix 13
Variable-Format Card 12
Problem Card 11
Comment Card 10
Comment Card 1

SAMPLE INPUT

INPUT FOR CANON

CORRELATION MATRIX

SECTION 1

ROW	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00	.86	.63	.75	.66	.60	.54	.78	.05	.57	-.03	.48
2	.86	1.00	.61	.79	.62	.50	.52	.66	.14	.43	-.05	.49
3	.63	.61	1.00	.61	.47	.34	.49	.68	.14	.33	-.10	.31
4	.75	.79	.61	1.00	.60	.44	.54	.67	.09	.36	.00	.37
5	.66	.62	.47	.60	1.00	.53	.41	.53	.50	.46	.04	.34
6	.60	.50	.34	.44	.53	1.00	.54	.51	.00	.35	.03	.28
7	.54	.52	.49	.54	.41	.54	1.00	.54	.04	.18	-.07	.24
8	.78	.66	.68	.67	.53	.51	.54	1.00	.09	.57	.01	.50
9	.05	.14	.14	.09	.05	.00	.04	.09	1.00	.21	.04	.19
10	.57	.43	.33	.36	.46	.35	.18	.57	.21	1.00	.29	.36
11	-.03	-.05	-.10	.00	.04	.03	-.07	.01	.04	.29	1.00	-.02
12	.48	.49	.31	.37	.34	.28	.24	.50	.19	.36	-.02	1.00

SAMPLE OUTPUT

```
>$$size 48000.
>$$load d canon(t16wwc).
LOADING STARTS AT LOC 060200


CANONICAL CORRELATIONS, 29 APRIL 1969


SUPPLY THE NUMBER OF VARIABLES IN THE LEFT SET(2 DIGITS)
> 8


SUPPLY THE NUMBER OF VARIABLES IN THE RIGHT SET(2 DIGITS)
> 4


SUPPLY THE NUMBER OF OBSERVATIONS (3 DIGITS)
>234

TYPE THE NAME OF YOUR CORRELATION MATRIX
DSNAME=>rmat(163rkf)

DO YOU WANT THE CORRELATION MATRIX PRINTED?
>no


 LEFT SET CANONICAL WEIGHTS, COLUMNWISE
      1         0.588    -1.549    -1.231    -1.143
      2         0.112     1.833     0.536     0.022
      3        -0.185     0.262    -1.143     0.703
      4        -0.288    -0.208     0.507     0.089
      5         0.225    -0.341     0.236     0.699
      6        -0.043    -0.113     0.295     0.163
      7        -0.245     0.210    -0.142    -0.808
      8         0.703     0.263     0.842     0.327


 RIGHT SET CANONICAL WEIGHTS, COLUMNWISE
      1        -0.166     0.646    -0.176     0.765
      2         0.809    -0.592    -0.429     0.357
      3        -0.184    -0.126     0.990     0.298
      4         0.442     0.677     0.484    -0.549
```

continued

```
FACTOR STRUCTURE FOR LEFT SET. COLUMNS ARE CANONICAL FACTORS. ROWS ARE TESTS.
   1          0.885     0.065    -0.204    -0.240
   2          0.731     0.509    -0.047    -0.140
   3          0.530     0.358    -0.578     0.253
   4          0.585     0.269     0.072    -0.052
   5          0.672    -0.059     0.071     0.276
   6          0.525    -0.059     0.144    -0.137
   7          0.337     0.271    -0.117    -0.472
   8          0.880     0.178     0.001     0.008


FACTOR    VARIANCE EXTRACTED  REDUNDANCY
  1            0.444            0.252
  2            0.072            0.008
  3            0.053            0.002
  4            0.058            0.001


TOTAL VARIANCE EXTRACTED FROM LEFT SET =        0.627


TOTAL REDUNDANCY FOR LEFT SET, GIVEN RIGHT SET =        0.263


NOTE THAT ALL VALUES ARE PROPORTIONS.


FACTOR STRUCTURE FOR RIGHT SET. COLUMNS ARE FACTORS. ROWS ARE TESTS.
   1          0.077     0.648    -0.128     0.747
   2          0.879    -0.251     0.009     0.406
   3          0.050    -0.280     0.850     0.443
   4          0.704     0.587     0.289    -0.276


FACTOR    VARIANCE EXTRACTED  REDUNDANCY
  1            0.319            0.181
  2            0.226            0.025
  3            0.206            0.008
  4            0.249            0.004


TOTAL VARIANCE EXTRACTED FROM RIGHT SET =        1.000


TOTAL REDUNDANCY FOR RIGHT SET, GIVEN LEFT SET =        0.217
```

continued

```
 NOTE THAT ALL VALUES ARE PROPORTIONS.

 WILKS LAMDA FOR TOTAL SET =      0.3656193

 CHI SQUARE FOR TOTAL =    228.9019928

 N.D.F. =     32

 CHI SQUARE TESTS WITH SUCCESSIVE ROOTS REMOVED

 ROOTS REMOVED   CANONICAL R   R-SQUARED   CHI-SQUARE   N.D.F.   LAMDA PRIME
       0            0.7530       0.567       228.90      32        0.3656
       1            0.3298       0.109        38.46      21        0.8445
       2            0.1954       0.038        12.26      12        0.9475
       3            0.1218       0.015         3.40       5        0.9852
M:END OF JOB
>
```

COST ESTIMATE

Unfortunately, exact figures for the time used by the job listed on the Sample Input are not available. As an approximate guide, the typical CANON job uses between $^1/_2$ and 2 minutes of computer time. At the current rate for the University of Pittsburgh time-sharing facility ($247./hr.), the approximate cost to the user is $4.12.

Charge to user = computer time + network overhead
= $4.12 (estimated) + network overhead

CONTENTS—CANON

pages

1– 2	Identification & Abstract
3– 5	User Instructions
7–10	I/O
11	Cost—Contents

DESCRIPTIVE TITLE	Program for Analysis of Linear Systems
CALLING NAME	PALS
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Dr. James Van Ness Electrical Engineering Department, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

PALS is actually a series of subroutines combined into one large main program for (1)forming the differential equations of a linear system in matrix form, (2)finding the eigenvalues of the coefficient matrix of the differential equations, and then (3)either computing the loci of the eigenvalues as individual or groups of parameters are varied, finding the eigenvectors of the coefficient matrix, or finding the sensitivities of the eigenvalues to the parameters of the system.

Although PALS was developed initially to study the load-frequency control of a large power system, it is presently written in a general form to make it applicable to many types of systems. The system to be studied may be described in terms of a block diagram or by sets of equations. The method of forming the coefficient matrix of the differential equations from this general input is described in Ref. 1. The only restriction is that the system must be representable by a set of linear differential equations with constant coefficients. Many nonlinear systems, such as the power system, can be studied for small deviations about an operating point by linearizing the system of equations about that operating point.

continued

The accuracy of PALS is dependent on the accuracy of the method used to find the eigenvalues and the eigenvectors of the coefficient matrix of the differential equations. Fortunately, the methods that have been chosen have proven to be very satisfactory. The QR transform developed by Francis[2] is used to find the eigenvalues and is described in Ref. 1. The eigenvectors are found by an inverse-iteration method based on a method described by Wilkinson.[3] After finding the eigenvectors, the program corrects the value found for the eigenvalues by using the Rayleigh quotient. The change in the eigenvalues is insignificant in most cases, but in the few where the accuracy of the QR transform is poor[2] the error is corrected at this step. The inverse-iteration method and the Rayleigh quotient also are described in Ref. 1.

PALS provides two methods of studying the effect of parameter changes on the system eigenvalues. The first is essentially the well-known root-loci approach. Any of the parameters in the system may be incremented through a series of steps, and the resulting change in the eigenvalues will be plotted on a complex plane. The second method finds the sensitivities of specified eigenvalues to the parameter (the derivatives of the eigenvalues to individual or groups of parameters). The sensitivity method thus gives the slope of the eigenvalue locus at a given point. It has the advantage of enabling the user to determine quickly which parameters are important in a given situation. However, the complete locus of the eigenvalue is needed to determine the effect of the parameter over any range of variation. The eigenvalue locus is found by actually incrementing the parameters, whereas the sensitivity is found by using the method described in Ref. 1.

Two versions of PALS are currently being maintained on the CDC 6400 computer. PALS1 is dimensioned for systems up to the 500th order; PALS2 is a simpler version for smaller systems, usually less than 100th order. The actual limits on each of these programs are given in Ref. 1.

REFERENCES

1. Van Ness, J.E., "PALS—A Program for Analyzing Linear Systems," Northwestern Univ. Dept. Elec. Eng. (Mar. 1969). Available from EIN for the cost of duplication and mailing.
2. Francis, J.G.F., "The QR Transformation," Computer J. *4*, 265–271 (Oct. 1961); *5*, 332–345 (Jan. 1962).
3. Wilkinson, J.H., *The Algebraic Eigenvalue Problem* (Oxford University Press, London, 1965).

USER INSTRUCTIONS

PALS will accept four types of jobs:

Job Type 1—finds the eigenvalues of the system and plots them on the complex plane. This is the first step of all four job types, but, if only Job Type 1 is specified, it is all that is done.

Job Type 2—finds the loci of the eigenvalues as certain specified parameters are varied. The increment given for each parameter is added at each step and the eigenvalues for the modified system found. Any section of the complex plane can be plotted to show how the eigenvalues in that section have moved.

Job Type 3—finds the derivatives of the eigenvalues with respect to the system parameters, the sensitivities of the system. The eigenvalues and the parameters to be considered are specified in the input data.

Job Type 4—finds the eigenvectors of both the regular and transposed system matrix for specified eigenvalues and stores them with the eigenvalues on a tape. This information can then be used for other studies of the system.

For any given job, the data can be considered to be in two parts. The first part describes the system to be studied and is common to all job types; it is all that is needed for Job Type 1. For Job Types 2, 3, and 4, a second set of data is needed to specify the eigenvalue loci, the sensitivities, or the eigenvectors to be found.

Base Data

Data-Identification Card

Any number of sets of data may be processed in one computer run. Each set of data will have as its first card a Data-Identification Card punched in the following format.

Columns	
1–30	An identifying name that will be reproduced on the output listing
33	Job Type number (1, 2, 3, or 4)
36	Print control—a 1, 2, or 3 punch, meaning the following. 1 (or blank, or zero): print only the identifying name and the results

continued

2: add to the printing under 1 the list of the state variables and the variables of constraint

3: add to the printing under 2 all of the input data

Naming the Variables

The first step in preparing the data is to assign names to all of the variables on the system. One to six alphanumeric or special characters may be used (except for the plus and minus signs).

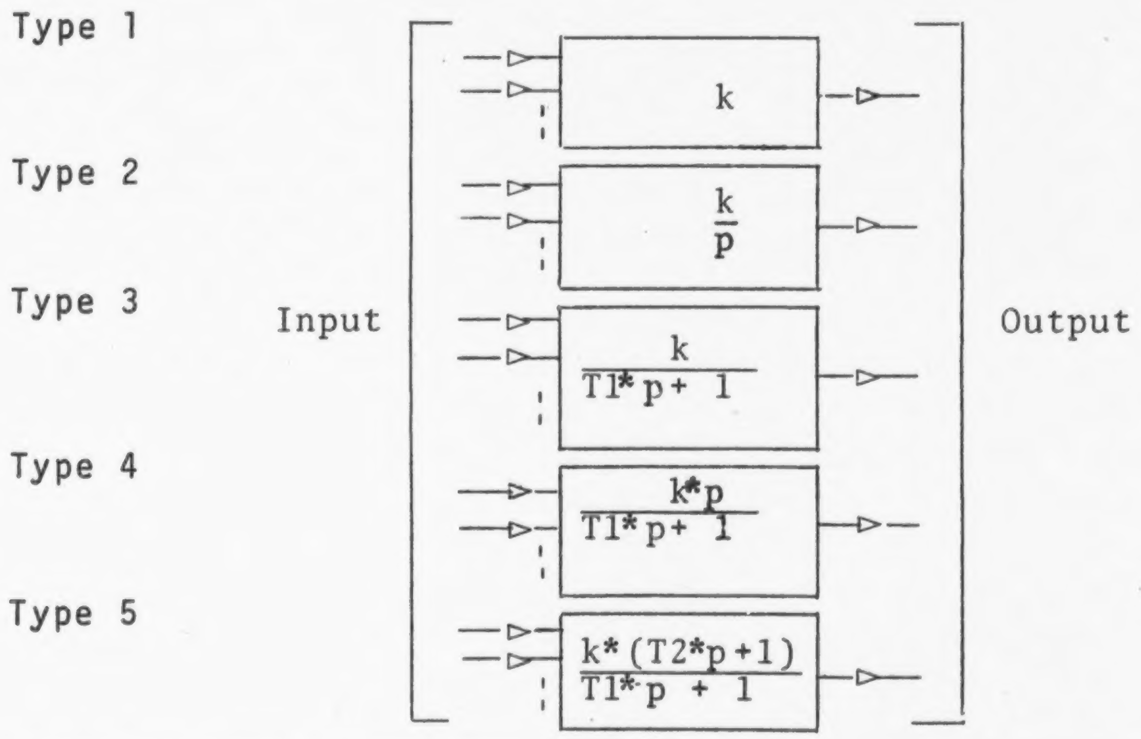
Each variable is defined either by being the output variable of one of the five standard transfer-function blocks or by being on the left hand of the equals sign in one of the equation inputs. Each variable must be defined once and only once. The BCD fields described below on the input cards for these names are *free-format* fields.

Input for Standard Blocks

The first five types of input are the standard transfer-function blocks; these are shown in Table I along with their card formats. A decimal point should be punched with the data, but the exponent (such as in E 10) is not needed.

TABLE I. Standard function blocks with card formats.

STANDARD BLOCKS—Types 1–5



continued

FIRST-CARD FORMAT

Columns	*Content*	*Format*
1–2	Type	I2
3	Blank or zero	I1
4	Blank	A1
5–10	Output-variable name	A6
11–20	Value for K	E10
21–30	Value for T1	E10
31–40	Value for T2	E10
41–50	Names	BCD
51–60	of	BCD
61–70	input variables	BCD
71–80	with sign	BCD

CONTINUATION-CARD FORMAT

Columns	*Content*	*Format*
1–2	Type	I2
3	*Nonzero* number	I1
4	Blank	A1
5–10	Output-variable name	A6
11–20	Names	BCD
21–30	of	BCD
⋮	input variables	⋮
	with sign	
71–80		BCD

The interconnections between the blocks in the diagram of the system being studied are given by listing the input variables for each block. The names of these variables, with a plus or minus sign to indicate their input sign, are punched one to each BCD field. The first blank field terminates the list. The first card can hold four names; any number of continuation cards with up to seven names per card can be added. The first ten columns of these continuation cards serve as an identification block and differ from the first ten columns of the first card only in that they must have a *nonzero* number in Col. 3. The continuation cards must follow directly behind their corresponding first card in the data deck.

continued

Equation Input

Differential or algebraic equations may be entered as data, either singly or in groups (matrices). They must have a single variable or derivative of a variable to the left of the equals sign and the coefficient to the left of the equals sign must be unity. The format for this type of input is given in Table II.

The first card or group of cards defines the names of the columns of the matrix. Column 2 will have the type number, and Cols. 3–10 will be blank unless continuation cards are needed, in which case Col. 3 will be a nonzero number. The names of the columns then follow, seven per card, with the list terminated by the first blank name. The names may be in any order desired, but they may be reordered by the program as the A matrix is formed. Thus, the printout may not be in the same order as the input cards.

After the columns have been defined, the equations or rows of the matrix are entered on data (D) cards. These cards have the type number in Col. 2, a blank or zero in Col. 3 for the first card, and a nonzero number for continuation cards, the letter D in Col. 4, and the name of the variable on the left of the equals sign in Cols. 5–10. This variable is defined by this equation or matrix row and must not be defined by any other equation or block in this set of data. The coefficients are then entered in the same order and the same number as on the cards defining the column names. Table II gives the formats for Types 8 and 9, and these two types are recommended for any equation input.

Terminating the Base Data

Any combination of the types described above may be used in one data deck. The end of the base data is indicated by a card with zeroes or blanks in Cols. 1 and 2. This card may be completely blank, or identifying information may be punched in Cols. 4–80.

EIGENVALUE LOCI DATA

When the loci of the eigenvalues are to be plotted (Job Type 2), the data cards listed below must immediately follow the deck of base data. Any number of loci may be called for after a set of base data, each having a control card followed by a card for each parameter to be incremented. The end of the data is indicated by a blank card.

continued

TABLE II. Matrix equations. Type 8 (differential equations) and Type 9 (algebraic equations)

FORM OF EQUATIONS

$$\begin{aligned} X &= 5.5\ A - 6.2\ B + 0.9\ C - 1.0\ D \\ Y &= 0.8\ A \qquad\qquad\ \ - 3.0\ C - 2.0\ D \\ Z &= 1.1\ A + 1.2\ B + 2.1\ C + 1.5\ D \end{aligned}$$

Either the variables (Type 9) or their derivatives (Type 8) may appear on the lefthand side of the equals sign. The matrix does not have to be square and the names of the columns do not have to be the same as the rows. Any missing terms, such as the B term in the second equation above, must be entered as a zero coefficient (or blank space) when making up the data cards.

COLUMN-NAME CARD FORMAT

Columns	*Content*	*Format*
1–2	Type	I2
3–10	Blank	(I1, A1, A6)
11–20	Column names (signs will be ignored)	BCD
21–30		BCD
⋮		⋮
71–80		BCD

Continuation cards are identical, except that Col. 3 must be a *nonzero* number.

---

continued

DATA-CARD FORMAT

Columns	*Content*	*Format*
1–2	Type	I2
3	Blank or zero	I1
4	D	A1
5–10	Row name	A6
11–20	Values of the coefficients in this row of the matrix	E10
21–30		E10
⋮		⋮
71–80		E10

Continuation cards are identical, except that Col. 3 must contain a *nonzero* number.

Control Card

The first card for each eigenvalue loci should have the following format.

Columns	*Contents*	*Format*
1–3	Blank	
4–6	Number of steps to be incremented	I3
7–9	Print control, a 1, 2, or 3 punch as defined below	I3
11–20	XMAX or XMIN	E10
21–30	XMAX or XMIN	E10
31–40	YMAX or YMIN	E10
41–50	YMAX or YMIN	E10

The area of the complex plane to be plotted for this loci is specified by XMAX, XMIN, YMAX, and YMIN. The maximum and minimum values for each axis may be listed in either order. This card may be used by itself with no parameter card following and with the number of steps (Cols. 4–6) zero, to give an enlarged plot of some area of the complex plane showing just the original eigenvalues.

The print control (Cols. 7–9) has the following code—

1 (or blank or zero): print only the eigenvalues as

continued

found by the QR transform after the original set has been found; the original set will be under the control of the Data-Identification Card at the start of the base data

2: add to 1 the printing of the eigenvalues sorted in the order of their real part

3: add to 2 the printing of all data under the control of the Data-Identification Card for this set of data

Parameter-Incrementing Data Card

The code for the parameter to be incremented is given in Table III. The format for this card is

Columns	*Contents*	*Format*
1–2	Parameter identifier	I2
3–10	Blank	
11–20	Output-variable name	A10
21–30	Increment to be added to parameter at each step (may be negative)	E10
31–40	Column name for parameter type 4; for parameter type 5 and input types 8 and 9, this should contain the number of the column of the matrix, punched in I8 format. (Thus, if there is one continuation card and the third item on it is to be incremented, a 10 (seven items on first card, plus three on second) is to be punched in Cols. 37–38.	A10

For input Types 1–5, the blocks of the block diagram, any combination of the parameters in any of the blocks may be specified, up to a maximum of 150 parameters for PALS1 or 100 parameters for PALS2, to be incremented in one eigenvalue loci. For example, the K, T1, and T2 of the same Type 5 block can be incremented together by including three incrementing data cards, one for each parameter.

For input Types 8 and 9, only one parameter per equation or row of the matrix may be incremented in any one eigenvalue loci, but parameters in different equations or rows may be incremented in one

continued

loci. If it is necessary to increment more than one parameter in a given equation, dummy variables and extra equations must be introduced.

TABLE III. Parameter identifiers.

Number	*Parameter*
1	K (Types 1–5)
2	T1 (Types 1–5)
3	T2 (Types 1–5)
5	Matrix element (Types 8 and 9)

SENSITIVITY DATA

When the sensitivity of the eigenvalues to the various parameters is to be found (Job Type 3), the data cards listed below must immediately follow the deck of base data. The first card specifies the number of eigenvalues for which the sensitivities are to be found. The following cards indicate the parameters with respect to which the derivatives are to be computed in each case. Any number of sensitivity cases may be computed. If the derivative is desired with respect to several parameters at once, Col. 3 of all except the first card in the group must be nonblank. The end of the sensitivity data is indicated by a card with zeroes or blanks in Cols. 1 and 2.

Eigenvalue-Specification Card

The first card following the base data is a control card that determines which eigenvalues will have their derivatives evaluated.

The format for this control card is as follows.

Columns	*Parameter*	*Format*
1–5	IEIGEN	I5
6–10	NSTPS	I5
11–20	EVU	F10.5
21–30	EVL	F10.5
31–35	ITN	I5

continued

The parameters are used in the following way—

1. If NSTPS (but not IEIGEN) is given, that number of eigenvalues will have their derivatives computed, starting from the one with the most positive real part and working towards the one with the most negative real part.
2. If both IEIGEN and NSTPS are given, with IEIGEN less than NSTPS, and the eigenvalues are considered numbered in order of their real part from the most positive to the most negative, then IEIGEN will be the number of the first one used and NSTPS the number of the last one used.
3. If IEIGEN is greater than NSTPS, or if both are blank, then all of the eigenvalues with real parts between EVU and EVL will be used, where EVU is more positive than EVL.
4. ITN is the number of times that the eigenvector and eigenvalue from the Rayleigh quotient will be recomputed if the change in the eigenvalue is greater than 0.01% at any computation of the Rayleigh quotient.

Parameter-Specification Card

The code for the parameter to be used in the derivative is given in Table III. The format for the parameter-specification card is

Columns	*Parameter*	*Format*
1–2	Parameter identifier	I2
3	If nonblank, this card's derivative is to be added to the previous card's derivative	A1
4–10	Blank	
11–20	Output-variable name	A10
21–30	Blank	
31–40	Column name for matrix element	A10

There are no limitations on combinations of elements that can be used in one derivative as long as no special types of input are used (see Appendix C of Ref. 1).

FINDING THE EIGENVECTORS

For Job Type 4, the eigenvectors of the specified eigenvalues will be found. An Eigenvalue-Specification Card as described in the Sensitivity-Data section must immediately follow the base-data deck. This is the only card needed. However, a blank card may be added

continued

at the end of the data as in the other job types.

The eigenvalues and eigenvectors will be written on a file called TAPE20 by the following FORTRAN statements. They may be read by some other program by using corresponding *read* statements.

```
WRITE (20) (ROOTR(I), ROOTI(I), I=1,N)   (called once)
WRITE (20) IROW, PRD, ROOTR(IROW), ROOTI(IROW), (X(I), V(I), I=1,N)
                    (called once for each eigenvalue, and once for
                     each pair of complex eigenvalues),
```

where ROOTR and ROOTI are the real and imaginary parts of the eigenvalue, IROW is the number of that eigenvalue and eigenvector, X is the eigenvector of the matrix A, V is the eigenvector of the matrix A transposed, and PRD is the dot product of X and V. X, V, and PRD are complex with the imaginary parts zero in the real case.

SIZE LIMITATIONS

	PALS1	PALS2
Number of differential equations or state variables	500	123[a]
Number of algebraic or constraint equations	500	70[a,b]
Number of Type 4 or 5 blocks in one problem	108	100
Number of input variables to one block (Type 1–5)	1000	160
Number of rows in a Type 8 or 9 matrix	500	160
Number of columns in a Type 8 or 9 matrix	728	160
Number of parameters that can be incremented in one eigenvalue loci	150	100
Number of parameters used in one derivative	500	500[c]

[a] For PALS2, the sum of the number of differential equations and algebraic equations must be no greater than 160.

[b] For PALS2, there can be more than 70 algebraic equations for Job Types 1, 2, and 4 as long as the limit in note 1 is met.

[c] For PALS1, no derivative matrix may have more than 800 elements. Since this is very hard to predict beforehand, a message will be printed whenever this limit is exceeded.

REFERENCES

1. Van Ness, J.E., "PALS—A Program for Analyzing Linear Systems," Northwestern Univ. Dept. Elec. Eng. (Mar. 1969). Available from the EIN office for the cost of duplication and mailing.

SAMPLE INPUT

Five examples are given to illustrate how some features of **PALS** may be used. The first four are based on the system shown in Fig. 1. They are examples of Job Types 1–4 and use a basic system defined entirely with standard blocks in a block diagram. Example 5 shows a system with an *open* input to a block.

A listing of the input cards for each example is given on pages 16–17. Vertical lines have been drawn on the listings after Cols. 10, 20, etc., to help in matching the listings to the data-card formats given in the User Instructions section.

Example 1: Job Type 1—to find and plot the eigenvalues of the system shown in Fig. 1. The first card contains an identifying title, the job type (1), and the print control (3). The next five cards are for the five blocks that make up the system. The last card, indicating the end of the base data, could be blank, but in this case, had a 00 punched in Cols. 1–2 to indicate that it was the last card. (The identification starting in Col. 5 is only for the convenience of the user and is ignored by the computer.)

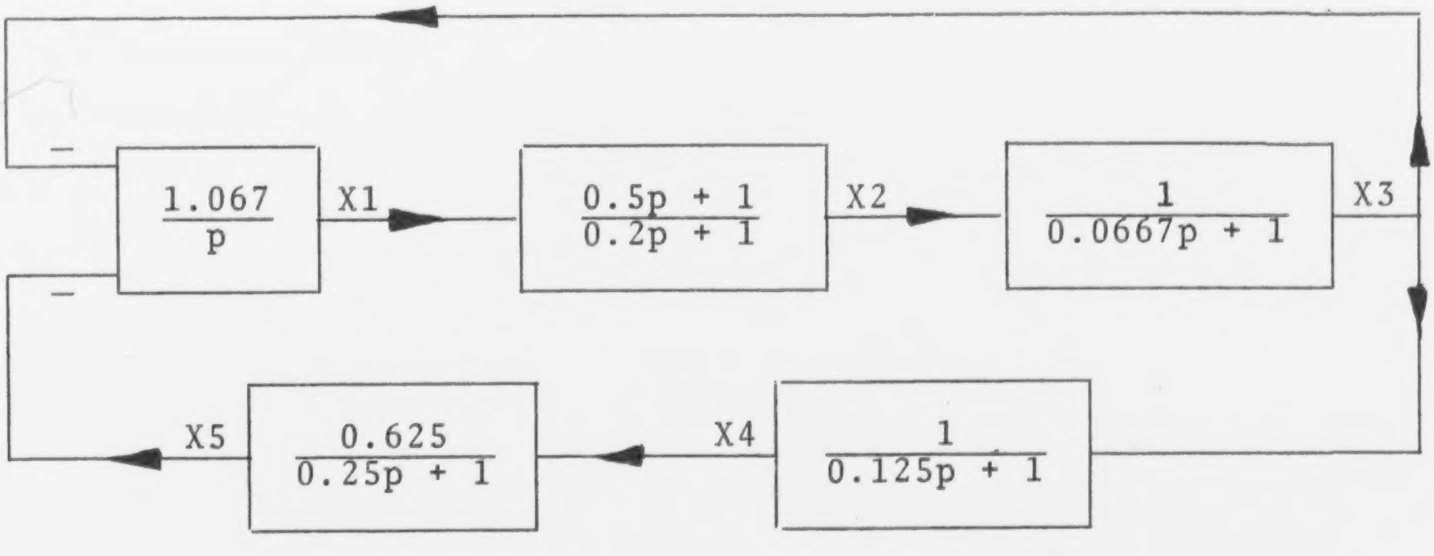


FIGURE 1. Block diagram for Examples 1–4.

continued

Example 2: Job Type 2—to plot an eigenvalue loci of the system in Fig. 1. The first seven cards, the base data, are identical to the cards of Example 1, except for the change in the job type in the first card. Three eigenvalue loci are called for. The first (specified by cards 8 and 9) is to have two increments and is to print only the minimum information for each increment. The limits on the plot are to be -15.0 and 0.0 on the real axis and 0.0 and 4.0 on the imaginary axis. The gain of the block X4 is to be increased by 0.1 at each increment of the eigenvalue loci.

The second loci (cards 10 and 11) differs from the first only in that the T2 variable of block X2 is to be incremented by 0.01. The third loci (cards 12 and 13) is in error and was included to test the error messages of PALS. (The 4 in Col. 2 of card 13 specified a matrix element, while variable X2 is defined by a Type 5 block. An error message will be printed, and the program will proceed to the next loci, if one is specified.

Example 3: Job Type 3—to find the eigenvalue sensitivities of the system in Fig. 1. Again the first seven cards are the same as in Example 1 (except for job type). The 5 in Col. 10 of card 8 specifies that the sensitivities of all five eigenvalues are to be found, although the program will automatically consider only one of a complex pair of eigenvalues when they occur. The 2 in Col. 35 of card 10 sets an upper limit of two retries with the Rayleigh quotient if the eigenvalues found by the QR transform are inaccurate. Actually this example will have no difficulties in finding the eigenvalues, and there will be no retries.

Six sensitivity cases are specified by the next seven cards, calling for the sensitivities with respect to various parameters of the blocks. The 1 punch in Col. 3 of the 14th card causes its sensitivity to be added to the previous card. The 15th card (blank) indicates the end of the data for this case.

continued

Example 4: Job Type 4—to find the eigenvectors, print them on the OUTPUT file, and write them on a file named TAPE20. The base data are the same as for the previous three examples, except for the specification of job type. One card is placed after the base data to specify which eigenvalues to use and how many retries should be made with the Rayleigh quotient if necessary. This card is the same as the card which follows the base data in Job Type 3. For Job Type 4, no further cards are needed. A blank card may be used to indicate the end of the data deck.

Example 5: Job Type 1 (with open block)—to handle a system with no input to noe of its blocks, such as the system shown in Fig. 2. The input cards for Job Type 1 based on this system are listed. It should be noted that the inputs for block A have been left blank. This system will have an eigenvalue of -0.1 from block A and a pair of complex eigenvalues from the closed loop. It is also permissible to set the gain of a block to zero to open a path or loop. (This has the same effect as omitting the inputs to that block.)

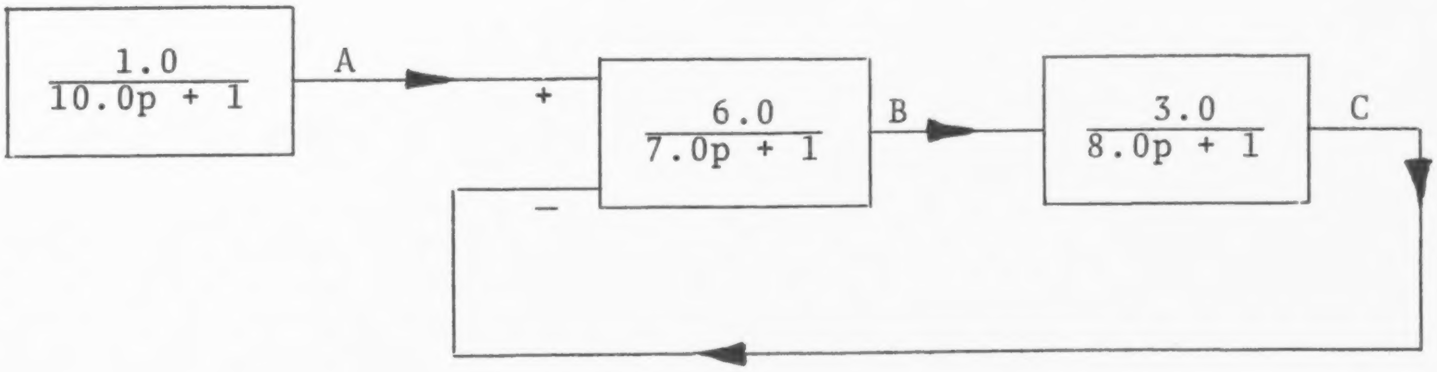


FIGURE 2. Block diagram for Example 5.

continued

Example 1—Job Type 1

```
   CLASS TEST CASE               1  3
 2  X1     1.067                         -X3        -X5
 5  X2      1.0     .2         .5        X1
030 X3      1.0     .0667                X2
 3  X4      1.0     .125                 X3
 3   X5    .625     .25                  X4
00  END SET I C
```

Example 2—Job Type 2

```
   CLASS TEST CASE               2  3
 2  X1     1.067                         -X3        -X5
 5  X2      1.0     .2         .5        X1
030 X3      1.0     .0667                X2
 3  X4      1.0     .125                 X3
 3   X5    .625     .25                  X4
00  END SET I C
     2  1   -15.0                           4.0
 1         X4         0.1
     2      -15.0                           4.0
 3           X2      0.01
     3  2   -15.0                           4.0
 4           X2      0.01
                    (blank card)
```

Example 3—Job Type 3

```
   CLASS TEST CASE               3  3
 2  X1     1.067                         -X3        -X5
 5  X2      1.0     .2         .5        X1
030 X3      1.0     .0667                X2
 3  X4      1.0     .125                 X3
 3   X5    .625     .25                  X4
00  END SET I C
          5                        2
 1          X2
 2          X2
 3          X2
 1            X3
 2            X3
 1          X2
 11         X3
                    (blank card)
```

continued

Example 4—Job Type 4

```
   CLASS TEST CASE              4  3
 2  X1    1.067                             -X3       -X5
 5  X2     1.0     .2        .5             X1
030 X3     1.0     .0667                    X2
 3  X4     1.0     .125                     X3
 3   X5   .625     .25                      X4
00  END SET I C
         5                        2
```

Example 5—Job Type 1 (with open block)

```
OPEN INPUT EXAMPLE.             1  3
 3   A     1.0      10.0
 3   B     6.0       7.0                     A          -C
 3   C     3.0       8.0                     B
                        (blank card)
```

Note:

PALS is also capable of handling more-complex systems than the examples given above. An example of such a system may be found in Van Ness, J.E., "PALS—A Program for Analyzing Linear Systems" [Northwestern Univ. Dept. Elec. Eng. (Mar. 1969)]. More-complex systems may include sets of nonlinear differential equations as input; such is the case in the example cited above.(which requires a rather lengthy explanation).

COST ESTIMATE

Unfortunately, the exact timing figures for the job listed in the Sample Input are not available. It is assured, however, that the amount of time expended on the central and peripheral processors is not sufficient to require a charge greater than $1.00 (Northwestern University minimum).

Nevertheless, for the majority of jobs for which PALS is well suited, it shall be the case that the charge for computer time exceeds the $1.00 minimum; consequently, there shall be a slightly higher *total* run charge.

Approximate charge to user = computer time + postage and handling + network overhead
= $1.00 (Northwestern minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—PALS

pages

pages	
1,2	Identification & Abstract
3–12	User Instructions
13–17	I/O
19	Cost—Contents

DESCRIPTIVE TITLE	Computer Means, Median, Frequencies
CALLING NAME	PROFILE NUCC112
INSTALLATION NAME	Vogelback Computing Center, Northwestern University
AUTHOR(S) AND AFFILIATION(S)	Betty Benson, Vogelback Computing Center, Northwestern University
LANGUAGE	CDC FORTRAN IV
COMPUTER	CDC 6400
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Lorraine Borman, EIN Technical Representative, Vogelback Computing Center, Northwestern University, 2129 Sheridan Road, Evanston, Ill. 60201 Tel.: (312) 492-3682

FUNCTIONAL ABSTRACT

PROFILE will give mean, median, sum, and frequency counts for up to 100 *integer-type* variables. Variables may come from 1-, 2-, or 3-column card fields. However, if many of them are 3-column, the number of variables that can be processed will be decreased proportionately.

In tabulating responses, PROFILE discriminates between blanks and punched zeroes. Blanks are considered to be "no response" and consequently are always excluded from the mean and median computation. This is built in and automatic, and it applies to all variables. On the other hand, the user may indicate (using the zero-exclusion card) for each variable whether zeroes are to be excluded or to be treated as "good" answers. For each variable where zeroes are good answers, only a count of *blank* responses will be printed, N (the number of responses) for that variable reduced accordingly, and the sum, mean, and median computed on the basis of the remaining good answers. For each variable where zeroes are excluded, counts of both blank responses and zero responses will be printed, both counts will be subtracted from N for that variable, and the sum, mean, and median will be computed for all *other* answers.

USER INSTRUCTIONS

Description of Input Data

Input data must be positive integer values.

Control-Card Preparation

Title Card

Columns	*Contents*
1–80	Any descriptive or identifying information of user's choice

Problem Card

Columns	*Contents*
1– 3	Number of variables (maximum 100)
4– 5	Blank
6	Variable-name option. Variables may be identified by name as well as number on the printout if desired. Punch 1 if variable names are wanted or 0 or blank if not. Variable-name cards must be provided if this option is exercised
7– 8	Blank
9	Number of format cards—maximum of 5
10	Blank
11–12	Punch 20 if input is from data tape; leave blank for card input

Format Cards

At least one and not more than five. Columns 1–80 are available for punching format. Specifications must be I type. Format card should begin with a left parenthesis in Col. 1.

Field-Width Card(s)

Column 1 for variable 1, Col.2 for variable 2, etc. If there are more than 80 variables, continue on to a second card. *Information to be punched:* width of the card field for the given variable; i.e., punch a 1 for 1-column variable, 2 for a 2-column variable, etc.

continued

Zero-Exclusion Card(s)

Column 1 for variable 1, etc. (same as field-width cards). If there are more than 80 variables, continue on to a second card. *Information to be punched:* punch a 1 if zero exclusion is desired for the given variable, otherwise zero or blank. Zero-exclusion cards may be entirely blank, i.e., if zeroes are always good answers and no zero exclusion is desired. However, card must be present (if more than 80 variables, 2 cards must be present).

Variable-Name Cards

Eight columns per variable name, 10 variable names per card, for as many cards as needed. Must be present if variable-name option was taken; must not be present if option was not taken.

Description of Output

For each variable, program prints out

(1) mean, median, sum
(2) frequency distributions
(3) number of blank responses (blanks are always excluded)
(4) number of zero responses (if zero exclusion was called for)
(5) number of "good" responses (N for that variable)

Limitations

Number of cases is unlimited.

Restriction on Number of Variables

For each 1-column variable, count 10
For each 2-column variable, count 100
For each 3-column variable, count 1000

Total count must not exceed 20000

Examples

(a) 50 one-column variables.....count 500 (50X10)
50 two-column variables.....count 5000 (50X100)
Total: 5500 OK

continued

or

(b)	18 three-column variables...count	18000
	16 two-column variables.....count	1600
	40 one-column variables.....count	400
	Total:	20000 OK

or

(c)	18 three-column variables...count	18000
	30 two-column variables.....count	3000
	Total:	21000 WRONG

Note: It is sometimes desirable to use only the first two columns (the leftmost two of a 3-column variable). This will

(a) save on storage requirements (count 100, not 1000)
(b) save on execution time
(c) reduce volume of output

In some cases, moreover, the frequency counts produced for the first two columns of a variable might be more meaningful than a complete breakdown of the 3-digit responses.

Job Deck Structure

```
(System cards)
Job Card
REQUEST(Tape 20  d) (If data are on tape)
LIBRARY ( PROFILE)
LGO.
7-8-9 EOR (multipunch in Col. 1)

     (Program-control cards)
       Title card (required)
       Problem card (required
       Format cards (1-5, as needed)
       Field-width cards (1 or 2, as needed)
       Zero-exclusion cards (1 or 2, as needed)
       Variable-name cards (optional)
       Data (if on cards)

6-7-8-9 EOI  (multipunch in Col. 1)
```

continued

NOTE: Multiproblem Processing

1. Data on Cards

Repeat the above, from program-control cards through data, separating the cards for each *problem* by a 7–8–9 EOR card. That is, a 7–8–9 EOR card must follow the last data card of each problem.

2. Data on Tape

Repeat program-control cards for each problem. End-of-record marks *on tape* must separate data for each problem. *No* 7–8–9 EOR *cards* are used to separate successive sets of program-control cards.

SAMPLE INPUT

```
LIBRARY(PROFILE)
LGO.
00000000000000000000  END OF RECORD
    EDUCATIONAL RESEARCH INVOLVEMENT OF INSTITUTIONS FOR TEACHER EDUCATION
 28  1  1
     (4X,4I1,2X,16I3,3I1,4I2,3XI3)
1111333333333333333333331112222 3
1111111111  1111111111111111
TYPE    LOCATIONSIZE    ACCRED  AREA    LEVEL   SOURCE  GRANTS  AGE-INSTSUBAREA
CURRIC. TP-RATIOORATIO  XVAL    YVAL    ZVAL    Q-RATIO GROUND  MOTIVE  PHILOS.
PLACEMT APPLIC. V-TYPE  TAT     ROHRSCH BERNREUTSKILLS  DEPTH
001 1111                                                                001
002 1111                                                                001
003 1111                                                                001
004 1111                                                                001
005 1111                                                                001
006 1111                                                                001
007 1121                                                                001
008 1122                                                                001
009 1122                                                                001
010 1122                                                    100         001
011 1122                                                  1 100         001
012 1123                                                  1 10000       001
013 1123                                                  1 10000       001
014 1123                                                  1 10000       001
015 1123                                                  1 10000       001
016 1223                                                  1 10000       001
017 1223                                                  1 1000000     001
018 1223                                                  1 1000000     001
019 1223                                                  1 1000000     001
020 1223                                                  1 100000000   001
021 1223                                                  1 100000000   001
022 1223                                                  1 100000000   001
023 1223                                                  1 100000000   001
024 1223                                                  1 100000000   001
025 1223                 000                        000   1 100000000   001
026 1223                 000                        000   1 100000000   001
027 1223                 000                        000   1 100000000   001
028 1223                 000                        000   1 100000000   001
029 1223                 000                        000   1 100000000   001
030 1223                 000                        000   1 100000000   002
031 1223                 000                        000   1 100000000   002
032 1223                 000                        000   1 100000000   002
033 1223                 000                        000   1 100000000   002
034 1223                 000                        000   1 100000000   002
035 1223                 000                        000   1 100000000   002
036 1223                 000                        0000001 100000000   002
037 1223  001            000                        0000001 100000000   002
038 1233  002            000                        0000001 100000000   002
039 1233  002            000                  000   0000001 100000000   002
                  .                   .               .
                  .                   .               .
                  .                   .               .

252 4863  18600300800300606000300300100100301602001003000522201030504
253 4863  18600300800300606100300300100100301802501103000522201030504
254 4863  19300300800400706300300300100100302202501203400522202030504
255 4863  20000301000500806500400400100100502402501203500522202040604
256 4863  20700301000500806800400400200100600702501203500522202050705
257 4863  20800301500500806800400500200100602503101503800522202050705
258 4863  23800301500601007000400500200100602503201504000522202050705
259 4863  24000401700601008300500600300100602503901604000722202050706
260 4863  25000401700601210000500600400200803104001704501322202060706
261 4863  25000501800601713400600600400201203204001805060322202060706
262 4863  25600501900602415000900600500201503904302005901522202090806
263 4863  26000502000702515200900800500305304409602006001822203120912
264 4863  28700502500802516400901200600310007010202006702022203151615
265 4863  34400602600902920002301501600500109610402507502022203161620
266 4863  42102103001003020002501602201200115313503010002822204203024
267 6965  42404004503610024004003005005000100715003020105022204040560
0000000000000000000000END OF INFORMATION
```

SAMPLE OUTPUT

```
              EDUCATIONAL RESEARCH INVOLVEMENT OF INSTITUTIONS FOR TEACHER EDUCATION
NO. OF VARIABLES= 28

FORMAT IS       (4X,4I1,2X,16I3,3I1,4I2,3XI3)

   FIELD WIDTHS ARE   1111333333
                      3333333333
                      11122223

ZERO EXCLUSIONS ARE   1111111111
                      ***1111111
                      11111111

BLANKS AND ERRORS ARE EXCLUDED FROM COMPUTATION OF MEAN AND MEDIAN. FOR ALL VARIABLES.
                                                                        ---

                              267 CASES PROCESSED
                              -------------------

              EDUCATIONAL RESEARCH INVOLVEMENT OF INSTITUTIONS FOR TEACHER EDUCATION

VAR.  1 TYPE          NO BLANKS OR ERRORS FOUND          NO ZERO RESPONSES
                                                                       SUM=         530
---------------

            RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ
            ----------     ----------     ----------     ----------     ----------
               1    89        2   125        3    23        4    29        6     1
  MEAN=   1.99
  MEDIAN=   2

VAR.  2 LOCATION      NO BLANKS OR ERRORS FOUND          NO ZERO RESPONSES
                                                                       SUM=        1089
---------------

            RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ
            ----------     ----------     ----------     ----------     ----------
               1    15        3    77        5    43        7    15        9     1
               2    40        4    32        6    23        8    21
  MEAN=   4.08
  MEDIAN=   4

VAR.  3 SIZE          NO BLANKS OR ERRORS FOUND          NO ZERO RESPONSES
                                                                       SUM=        1035
---------------

            RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ
            ----------     ----------     ----------     ----------     ----------     ----------
               1     6        2    31        3    79        4    61        5    54        6    36
  MEAN=   3.88
  MEDIAN=   4

VAR.  4 ACCRED        NO BLANKS OR ERRORS FOUND          NO ZERO RESPONSES
                                                                       SUM=         785
---------------

            RESP  FREQ     RESP  FREQ     RESP  FREQ     RESP  FREQ
            ----------     ----------     ----------     ----------
               1     7        2     4        3   255        5     1
  MEAN=   2.94
  MEDIAN=   3
```

continued

```
VAR. 5 AREA        36 BLANK RESPONSES (OR ERRORS)     NO ZERO RESPONSES                              231 (GOOD) RESPONSES
                                                                           SUM=       11476
----------------

          RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ
          ----------    ----------    ----------    ----------    ----------    ----------    ----------    ----------
             1     1      13     2      30     3      44     1      61     1      88     1     124     1     200     1
             2     4      14     1      31     1      45     3      62     1      90     2     125     1     207     1
             3    10      15     2      32     4      46     4      63     1      92     1     126     1     208     1
             4    15      17     2      33     2      48     1      65     2     100     1     127     1     238     1
             5    22      18     1      34     3      50     4      66     1     103     1     128     1     240     1
             6    12      19     1      35     1      52     2      67     1     104     1     130     1     250     2
             7    10      20     7      36     1      53     1      70     1     107     1     131     1     256     1
             8     4      21     1      38     3      54     1      72     1     108     1     140     1     260     1
             9     9      22     2      39     1      55     2      73     1     110     1     151     1     287     1
            10     8      24     3      40     3      56     1      74     2     115     1     164     1     344     1
            11     1      25     2      41     1      59     1      78     3     119     3     186     2     421     1
            12     5      26     1      42     1      60     1      85     2     120     2     193     1     424     1
  MEAN=  49.68
  MEDIAN=  20
             .                                   .                                       .
             .                                   .                                       .
             .                                   .                                       .

VAR. 27 SKILLS     19 BLANK RESPONSES (OR ERRORS)    166 ZERO RESPONSES                               82 (GOOD) RESPONSES
                                                                           SUM=         283
----------------

          RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ
          ----------    ----------    ----------    ----------    ----------    ----------
             1    41       3     6       5     3      12     1      20     1      60     1
             2    19       4     4       6     4      15     1      24     1
  MEAN=   3.45
  MEDIAN=   1

VAR. 28 DEPTH      18 BLANK RESPONSES (OR ERRORS)     54 ZERO RESPONSES                              195 (GOOD) RESPONSES
                                                                           SUM=        2452
----------------

          RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ    RESP  FREQ
          ----------    ----------    ----------    ----------    ----------    ----------    ----------    ----------
             1    29       5    10       9     5      14     1      20     5      30     3      40     3      55     1
             2    32       6     3      10    11      15     6      21     1      33     1      45     2      60     2
             3    16       7     8      11     2      16     2      22     1      35     4      46     1     116     1
             4    22       8     6      12     6      18     2      24     2      38     3      50     3     365     1
  MEAN=  12.57
  MEDIAN=   4


FIN
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 4.143 seconds for central-processor time and 12.847 seconds for peripheral-processor time with a memory usage of 25,000 words. Chargeable computer time was $1.00 (NU minimum job charge).

Charge to user = computer time + postage and handling + network overhead
= $1.00 (NU minimum) + $15.00 + network overhead
= $16.00 + network overhead

CONTENTS—PROFILE

pages
1 Identification & Abstract
3–6 User Instructions
7–9 I/O
11 Cost—Contents

DESCRIPTIVE TITLE	Statistical Analysis of Single Equation Models
CALLING NAME	QSASE
INSTALLATION NAME	Pennsylvania State University Computation Center
AUTHOR(S) AND AFFILIATION(S)	M.C. Hallberg Department of Agricultural Economics and Rural Sociology Pennsylvania State University
LANGUAGE	FORTRAN IV
COMPUTER	IBM 360/67
PROGRAM AVAILABILITY	Decks and listings presently available
CONTACT	Dr. Daniel L. Bernitt, 105 Computer Building, Pennsylvania State University, University Park, Pa. 16802 Tel.: (814) 865-9527

FUNCTIONAL ABSTRACT

QSASE is a self-contained library program designed to compute ordinary least-squares estimates of single equation regression models such as iterative least-squares estimates of special nonlinear regression models (as described in Ref. 1), and two-stage least-squares or limited information maximum likelihood estimates for systems of simultaneous regression equations (as described in Ref. 2). For additional details concerning all options, the user should consult the above references. The following options are available.

1. listing descriptive information about the problem and naming variables
2. using original observations or sums of squares and crossproducts (SSCP) as input data
3. performing various data-editing operations on the input data
4. reading input data from tape or cards
5. printing and/or punching SSCP in either raw form or corrected form
6. printing zero-order correlation matrix

continued

7. printing the mean, standard deviation, standard error of mean, and sum for each variable in the data deck
8. producing a separate listing of all zero-order correlation coefficients that exceed in absolute value a prespecified level
9. producing a scatter diagram of any variable against any other variable
10. stepwise least-squares where a least-squares regression is run and that variable with the smallest t ratio is eliminated in an iterative fashion until all t ratios exceed a prespecified level
11. two-step least squares where a least-squares regression is run and all variables are eliminated whose t ratio do not exceed a prespecified level
12. computing and printing the F ratio for testing the hypothesis that a linear combination of a subset of the k–1 β's for a single-equation model are all zero
13. computing and printing the t ratio for testing the hypothesis that a linear combination of a subset of the k–1 β's for a single-squation model is equal to a specified value
14. computing and/or printing for each observation the value of the dependent variable Y_t, the estimate of Y_t from the computed regression $\hat{Y}_t$, the estimated error $Y_t-\hat{Y}_t$, and the percentage error
15. producing a scatter diagram of the errors $Y_t-\hat{Y}_t$ against any other variable in the data deck
16. two-stage least-squares estimation
17. limited-information maximum-likelihood estimation

REFERENCES

1. Hallberg, M.C., "Statistical Analysis of Single Equation Stochastic Models Using the Digital Computer," Penn. State Univ. Dept. Agric. Econ. & Rural Sociol. Rep. 78 (February 1969). Copies of this report can be obtained through the contact person.

2. Hallberg, M.C., "Statistical Analysis of System of Simultaneous Linear Equations Using the Digital Computer," Penn. State Univ. Dept. Agric. Econ. & Rural Sociol. Rep. 69 (September 1967). Copies of this report can be obtained through the contact person.

USER INSTRUCTIONS

Control and Data Cards

The data and control cards required by QSASE, as well as the output for each option desired, are described in the manuals cited below.

Job Deck Structure

```
JOB Card
//EXEC LIBRARY,PARM=QSASE
//DATA.INPUT DD *
All Control Cards and Data Cards required by QSASE
/*
```

NOTE: JOB Card will be prepared for the user at the Computation Center.

REFERENCES

Hallberg, M.C., "Statistical Analysis of Single Equation Stochastic Models Using the Digital Computer," Penn. State Univ. Dept. Agric. Econ. & Rural Sociol. Rep. 78 (February 1969). Copies of this report can be obtained through the contact person.

Hallberg, M.C., "Statistical Analysis of System of Simultaneous Linear Equations Using the Digital Computer," Penn. State Univ. Dept. Agric. Econ. & Rural Sociol. Rep. 69 (September 1967). Copies of this report can be obtained through the contact person.

SAMPLE INPUT

```
// EXEC LIBRARY,PROG=0SASE
//DATA.INPUT DD *
                   22         9             1              1
TITLE    THIS PROBLEM AND THESE DATA ARE FROM L. R. KLEIN. ECONOMIC FLUCTUATIONS
TITLEIN THE UNITED STATES 1921-1941. COWLES COMMISSION MONOGRAPH #11. WILEY.1950
TITLEWE SHALL BE CONCERNED WITH ESTIMATING THE CONSUMPTION FUNCTION IN KLEIN'S
TITLE6-EQUATION MODEL OF THE UNITED STATES ECONOMY.  THE VARIABLES ARE DEFINED
TITLEAS FOLLOWS(ALL VARIABLES ARE EXPRESSED IN CONSTANT DOLLARS):
TITLE
TITLE
TITLE     VARIABLE                  NAME
TITLE         1               CONSUMPTION
TITLE         2               NET INVESTMENT
TITLE         3               GOVERNMENT EXPENDITURES
TITLE         4               NET NATIONAL PRODUCT
TITLE         5               BEGINNING YEAR STOCK OF CAPITAL
TITLE         6               NON-WAGE INCOME
TITLE         7               PRIVATE LABOR INCOME
TITLE         8               GOVERNMENT LABOR INCOME
TITLE         9               GNET NATIONAL INCOME
TITLE        10               INDIRECT TAXES
TITLE        11               TIME(T=1 IN 1920)
TITLE        12               TOTAL WAGE BILL
TITLE        13               LAGGED NON-WAGE INCOME
TITLE        14               LAGGED NET NATIONAL PRODUCT
TITLE
TITLE
NAME      1C
NAME      2I
NAME      3G
NAME      4NNP
NAME      5K
NAME      6Y-NON-WAGE
NAME      7Y-PRIVATE
NAME      8Y-GOVT
NAME      9NNI
NAME     10TX
NAME     11TIME
NAME     12WAGE BILL
NAME     136 LAGGED
NAME     144 LAGGED
EDIT 2 -1.          4.        9.         10.
EDIT10                                   11.
EDIT 2  1.         7.        8.         12.
EDIT 8             6.        1.         13.
EDIT 2 -1.         4.        8.         4.
EDIT 8              4.        1.         14.
          (4X,9F6.1)
1920  39.8   2.7   4.6  47.1 180.1  12.7  28.8   2.2  43.7
1921  41.9  -0.2   6.6  48.3 182.8  12.4  25.5   2.7  40.6
1922  45.0   1.9   6.1  53.0 182.6  16.9  29.3   2.9  49.1
1923  49.2   5.2   5.7  60.1 184.5  18.4  34.1   2.9  55.4
1924  50.6   3.0   6.6  60.2 189.7  19.4  33.9   3.1  56.4
1925  52.6   5.1   6.5  64.2 192.7  20.1  35.4   3.2  58.7
1926  55.1   5.6   6.6  67.3 197.8  19.6  37.4   3.3  60.3
1927  56.2   4.2   7.6  68.0 203.4  19.8  37.9   3.6  61.3
1928  57.3   3.0   7.9  68.2 207.6  21.1  39.2   3.7  64.0
1929  57.8   5.1   8.1  71.0 210.6  21.7  41.3   4.0  67.0
1930  55.0   1.0   9.4  65.4 215.7  15.6  37.9   4.2  57.7
1931  56.9  -3.4  10.7  58.2 216.7  11.4  34.5   4.8  50.7
```

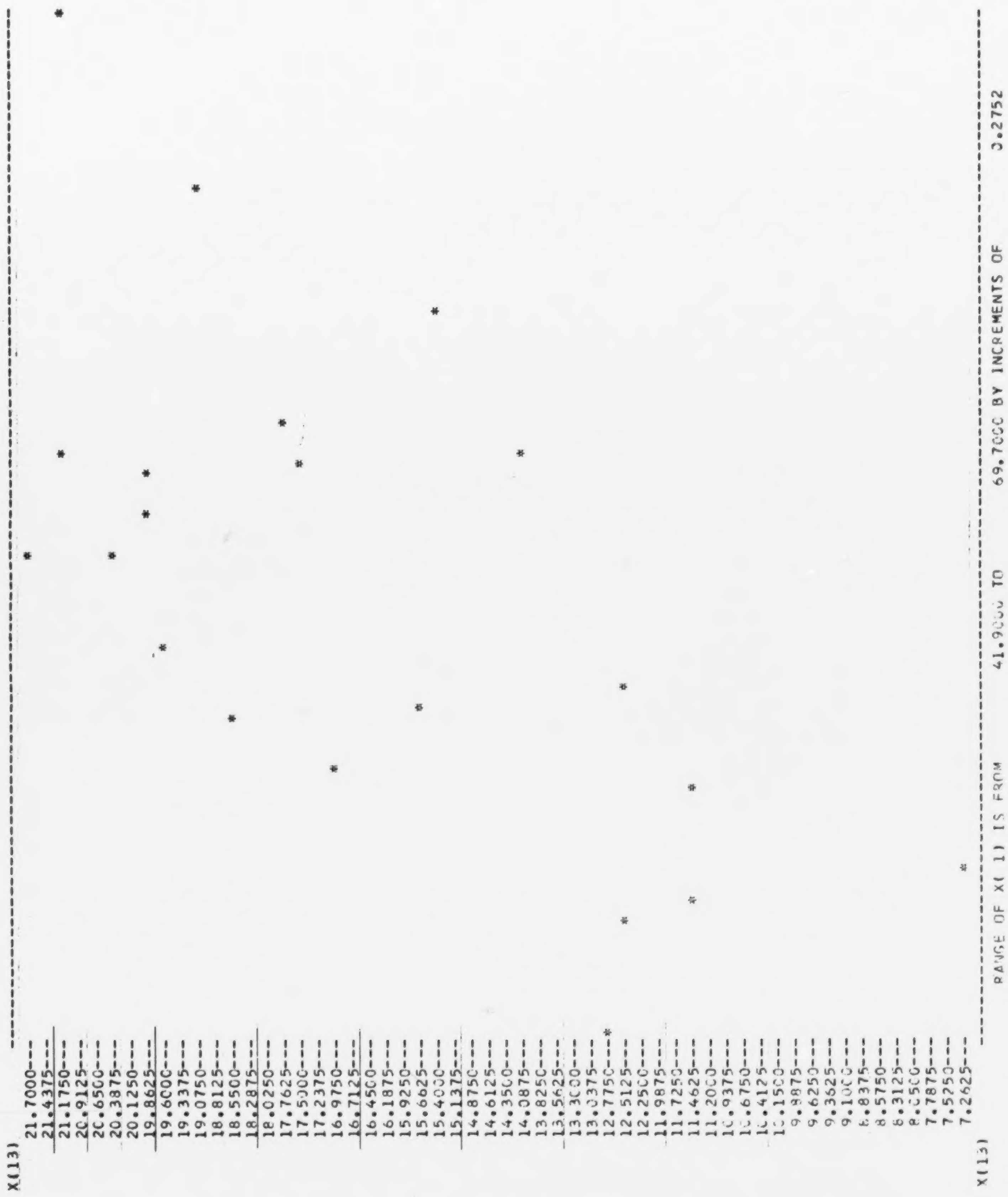
continued

```
1932  45.6  -6.2  10.2  49.6 213.3   7.0  29.0   5.3  41.3
1933  46.5  -5.1   9.3  50.7 207.1  11.2  28.5   5.6  45.3
1934  48.7  -3.0  10.0  55.7 202.0  12.3  30.6   6.0  48.9
1935  51.3  -1.3  10.5  60.5 199.0  14.0  33.2   6.1  53.3
1936  57.7   2.1  10.3  70.1 197.7  17.6  36.8   7.4  61.8
1937  58.7   2.0  11.0  71.7 199.8  17.3  41.0   6.7  65.0
1938  57.5  -1.9  13.0  68.6 201.8  15.3  38.2   7.7  61.2
1939  61.6   1.3  14.4  77.3 199.9  19.0  41.6   7.8  68.4
1940  65.0   3.3  15.4  83.7 201.2  21.1  45.0   8.0  74.1
1941  69.7   4.9  22.3  96.9 204.5  23.5  53.3   8.5  85.3
999     13                   1
   1                                1     4     1
061312
F   2 612
T   2     6    1.    13  -1.
```

SAMPLE OUTPUT

```
    THIS PROBLEM AND THESE DATA ARE FROM L. R. KLEIN. ECONOMIC FLUCTUATIONS
IN THE UNITED STATES 1921-1941. COWLES COMMISSION MONOGRAPH #11. WILEY,1950
WE SHALL BE CONCERNED WITH ESTIMATING THE CONSUMPTION FUNCTION IN KLEIN'S
6-EQUATION MODEL OF THE UNITED STATES ECONOMY.  THE VARIABLES ARE DEFINED
AS FOLLOWS(ALL VARIABLES ARE EXPRESSED IN CONSTANT DOLLARS):

     VARIABLE                     NAME
        1               CONSUMPTION
        2               NET INVESTMENT
        3               GOVERNMENT EXPENDITURES
        4               NET NATIONAL PRODUCT
        5               BEGINNING YEAR STOCK OF CAPITAL
        6               NON-WAGE INCOME
        7               PRIVATE LABOR INCOME
        8               GOVERNMENT LABOR INCOME
        9               GNET NATIONAL INCOME
       10               INDIRECT TAXES
       11               TIME(T=1 IN 1920)
       12               TOTAL WAGE BILL
       13               LAGGED NON-WAGE INCOME
       14               LAGGED NET NATIONAL PRODUCT

               OPERATION                        LOCATION OF
                                                NEW VARIABLE

  X( 4) PLUS    -1.000*X( 9)                        10
  TIME VARIABLE CONSTRUCTED STARTING WITH UNITY     11
  X( 7) PLUS     1.000*X( 8)                        12
  X( 6) LAGGED 1 TIME PERIODS                       13
  X( 4) PLUS    -1.000*X( 3)                         4
  X( 4) LAGGED 1 TIME PERIODS                       14


NUMBER OF OBSERVATIONS RETAINED IS       21

BEGIN READING DATA ACCORDING TO FORMAT
(4X,9F5.1)
      21 OBSERVATIONS WERE READ FROM CARDS OR TAPE.  THE FOLLOWING IS A CARD IMAGE OF THE FIRST CARD FOLLOWING THE LAS
         CARD WHICH WAS READ AND INTERPRETED AS A DATA CARD

                                          ****
        ****999     13             1                                                  ****
                                          ****
```

continued


X(13)
21.7000
21.4375
21.1750
20.9125
20.6500
20.3875
20.1250
19.8625
19.6000
19.3375
19.0750
18.8125
18.5500
18.2875
18.0250
17.7625
17.5000
17.2375
16.9750
16.7125
16.4500
16.1875
15.9250
15.6625
15.4000
15.1375
14.8750
14.6125
14.3500
14.0875
13.8250
13.5625
13.3000
13.0375
12.7750
12.5125
12.2500
11.9875
11.7250
11.4625
11.2000
10.9375
10.6750
10.4125
10.1500
9.8875
9.6250
9.3625
9.1000
8.8375
8.5750
8.3125
8.0500
7.7875
7.5250
7.2625
X(13)
RANGE OF X(1) IS FROM 41.9000 TO 69.7000 BY INCREMENTS OF 0.2752

continued

```
                                  LEAST SQUARES REGRESSION ANALYSIS

JOBNO                                   1
PARAMETERS TO BE ESTIMATED              4
DEGREES OF FREEDOM                     17      DEPENDENT VARIABLE IS  1  C



ITERATION NO    1

SOURCE              TSS            SSE           MSE             SSR           MSSR          F-RATIO          R-SQU...

DEGREES OF FREEDOM   21    ***      17        **********          3                   ********

           941.4295238      17.8794437     1.0517323     923.5500751    307.9500250    292.7075948      0.9810082


STANDARD ERROR OF ESTIMATE =          1.02554    R-SQUARE CORRECTED FOR DEGREES OF FREEDOM =     0.9776567



   VARIABLE                    REGRESSION COFF       ST ERROR            STUDENT T     BETA COEFFICIENT      ST ERROR OF BETA
Y-NON-WAGE       6               0.19293438         0.09121017          2.11527273        0.11867562            0.05610417
WAGE BILL       12               0.79621875         0.03994392         19.93341549        0.87687132            0.04399002
6 LAGGED        13               0.08983490         0.09064794          0.99158238        0.05277306            0.05322106
          CONSTANT              16.23660027         1.30269827         12.46382271

F RATIO =              248.7723 FOR THE FOLLOWING VARIABLES
 6 12


THE LINEAR COMBINATION OF ESTIMATES ON VARIABLES
                  6     13
WITH WEIGHTS   1.00  -1.00
IS             0.10305 WITH VARIANCE          0.02707720 AND STUDENT T          0.62624448



DETERMINANT OF CORRELATION MATRIX OF INDEPENDENT VARIALBES=                     0.2357978225 (A VALUE OF 1 INDICATES PERFECT
ORTHOGONALITY WHILE A VALUE OF 0 INDICATES MATRIX SINGULARITY OR PERFECT MULTICOLLINEARITY)

DIAGONAL ELEMENTS OF THE INVERSE OF THE CORRELATION MATRIX OF THE INDEPENDENT VARIABLES
          2.81756            1.73217             2.53542
```

continued

```
VARIABLE        6                  12                  13

    6     0.79100879D-02
   12    -0.12540135D-02     0.15170370D-02
   13    -0.50111901D-02    -0.63806994D-03     0.78128710D-02



                            ERROR ANALYSIS

              Y                  Y HAT             ERRORS           PERCENT ERROR

          41.90000            42.22389           -0.32389            -0.77302
          45.00000            46.25001           -1.25001            -2.77780
          49.20000            50.76574           -1.56574            -3.18240
          50.60000            51.09350           -0.49350            -0.97530
          52.60000            52.59239            0.00761             0.01446
          55.10000            54.23090            0.86910             1.57731
          56.20000            54.86152            1.33848             2.38163
          57.30000            56.24502            1.05498             1.84115
          57.80000            58.38856           -0.58856            -1.01826
          55.00000            54.71769            0.28231             0.51329
          50.90000            51.12965           -0.22965            -0.45119
          45.60000            45.92213           -0.32213            -0.70643
          46.50000            46.17772            0.32228             0.69308
          48.70000            48.75801           -0.05801            -0.11912
          51.30000            51.33466           -0.03466            -0.06757
          57.70000            56.08350            1.61650             2.80156
          58.70000            59.13597           -0.43597            -0.74271
          57.50000            57.28995            0.21005             0.36531
          61.60000            60.61080            0.98920             1.60585
          65.00000            64.21492            0.78508             1.20781
          69.70000            71.87345           -2.17345            -3.11829


DURBIN WATSON STATISTIC    =      1.3674740483

HART-VON NEUMANN RATIO     =      1.4358477507

SUM OF ERRORS              =      0.0000000000

ERROR SUM OF SQUARES       =     17.8794487006

SUM OF SQUARES OF Y-HAT    =  62148.7505512993 (UNCORRECTED)
```

COST ESTIMATE

For the job listed on the Sample Input, the total running time was 13 seconds. At the current rate for computer time ($0.11/sec.) at the Pennsylvania State University, the chargeable time amounts to $1.43.

Charge to user = computer time + network overhead
= $1.43 + network overhead

CONTENTS—QSASE

pages
1– 2 Identification & Abstract
3 User Instructions
5–10 I/O
11 Cost—Contents